Railway and Locomotive Engineering

A Practical Journal of Motive Power, Rolling Stock and Appliances

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INDEX FOR VOLUME XXXII, 1919

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A Practical Journal of Motive Power, Rolling Stock and Appliances

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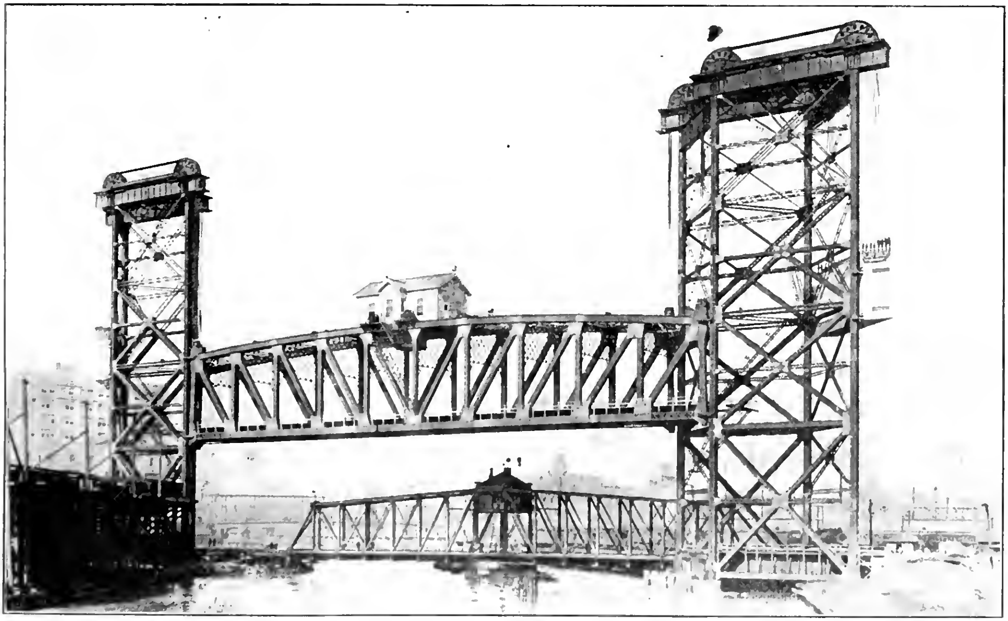
Lift Span Bridge Over the South Branch of the Chicago River, No. 458, Pennsylvania Lines

The success which has attended the operation of the lift span bridge over the south branch of the Chicago River, near 19th Street, known as Bridge No. 458, Pennsylvania Lines, marks it as not only the largest structure of its kind, but in all likehood as the most durable. The balanced by two counterweights of 800 tons each.

As shown in our frontispiece the new span is supported by two towers, the lift being 112 ft. The Government required that the lift span should be erected 120 ft. above the river, the normal clearance 40 tons each. The four sheaves on the top of each tower weigh 31 tons each and are the largest of their kind so far built. They are 15 ft. pitch diameter and each pair carries sixteen 2¼ ins. plow steel ropes, each weighing with its sockets about 2,000 lbs.



LIFT SPAN, BRIDGE NO. 458, PENNSYLVANIA LINES, VIEW FROM CANAL STREET BRIDGE, CHICAGO, ILL.

bridge carries the double track of the Pennsylvania Lines, and in addition will be also used by the Chicago & Alton, and the Pere Marquette. The traffic at present will involve lifting and lowering at least 1,500 times a year, the movable portion weighing 1,600 tons, which is counter- of the span when lifted. There was nothing unusual in the erection of the towers, the derricks being stepped up from story to story according to practice common for similar structures. The heaviest pieces on them are the bottom sections of the vertical legs next to the lift span which weigh

The span erection was carried on with two A-frame derricks, the work progressing on the two sides simultaneously. Only enough falsework to carry the end panel of the span was first set from the towers, and after the erection of these panels the derricks were moved from the towers to

their first positions on the span, directly above the two sway frames nearest the ends. To regulate the temporary camber to suit the erection of the last pieces of top chord four hydraulic jacks were set

VIEW OF SOUTH TOWER.

beneath the bottom chord, immediately above the ends of the four last members of the falsework. Because of the eccentric loading of the towers there was expected to be some deflection of each tower toward the river, but calculations and measurements had been so carefully made that the two center pieces of bottom chord, 73 ft. 6 ins. in length and weighing 36 tons each, when lowered into place fitted so exactly that the erection bolts could be entered without the use of drift pins. To get the last pieces of top chord in it was necessary to use the jacks.

It may be stated that in a few years it is planned to raise the grade at this crossing, and the design of the bridge was carried out with this idea in view. Aside from raising the floor systems in the towers, lowering one story of tower bracings, and raising the bare castings of the lift-span, no change in this bridge will be necessary to accomplish this end.

The span is operated by two 300 horse power series motors drawing their power from a 120-cell storage battery. An electrical indicator and limit switch connected to the drive by worm-gear reduction, indicates by lights in the operator's house, which is located in the top of the center of the span, the indicator showing the point traveled by the span, and cuts the controller circuit near each limit of travel, thereby breaking the main circuit, stopping the motors, and applying the brakes.

In common with the Halsted Street Bridge and others of this kind the motor is connected by a train of gears to operating drums, two over each top chord. Two operating ropes are fastened by rope clips to each of these drums, one for the upward movement of the span, and the other for the downward, and are so wound on the grooves of the drum that the up-haul rope is wound on while the down-haul rope is paid off, and vice versa. An up-haul rope runs from each drum to the corresponding corner of the lift span, then over a double-grooved deflector sheave, and thence to the top of th tower, to which it is connected. The down-haul rope parallels the up-haul as far as the deflecter sheave, and there, passing downward over the other groove in the latter, connects to the tower at a point in convenient reach of the deck.

To keep the span in proper alignment between the towers, vertical tracks are provided on the four tower legs adjacent to it, and on these tracks bear the rollers which hold the span both in transverse and longitudinal alignment. Automatic locks hold the bridge down when once seated. Each lock consists of two cams locked together by two segmental gears, and counterweighted to swing toward each other and grip a link hanging from the floor beam of the lift span. The counterweights in some bridges of this kind are made of cast iron, but considerable saving has been made by the use of concrete on the new and largest structure. A patented form of equalizer which makes the sixteen ropes receive their haul

NORTH TOWER OF BRIDGE, SHOWING COUNTER BALANCE

from a single pin also effects a material saving in space over other types, and completely avoids the possibility of the failure of any single rope.

Railroad Executive Committee.

Over 125 executives, representing nearly all the railroads in the United States, met last month in the New York Chamber of Commerce and expressed their views in regard to the readjustment to peace conditions. With almost complete unanimity they agreed to leave the matter of defining remedial legislation looking to the return of the roads to private operation to an enlarged railway executive advisory committee. To the sixteen members of the committee eight were added, consisting of Charles Hayden, of Hayden, Stone & Co., president Chicago, Rock Island & Pacific Railway Company, and Minneapolis & St. Louis; Samuel M. Felton, president of the Chicago Great Western and now director of Military Transportation; William Church Osborn, general counsel of the El Paso & Southwestern; Henry Ruhlender, chairman of the St. Louis & San Francisco; L. E. Johnson, president of the Norfolk & Western; E. E. Loomis, president of the Lehigh Valley; W. R. Cole, president of the Nashville, Chattanooga & St. Louis, and Bird M. Robinson, president of the American Short Line Association.

Thomas De Witt Cuyler, chairman of the committee, presided. Alfred F. Thom, general counsel, reported that the roads are assured of $175,000,000 in the aggregate by concessions granted by the United States Railroad Administration. This is an allowance on depreciation, retirement and salvage of equipment. The committee has no desire to escape responsible public regulation. All they desire is a fair relation between rates, wages and dividends, which will stimulate business, adequately reward labor and attract the new capital needed for expansion. They desire that all the good features of Federal control will be retained. The next meeting of the committee will be called probably in January in Chicago.

An Appeal to Employers.

The professional division of the United States Department of Labor has appealed to us to aid the department in their laudable work of placing thoroughly equipped officers and men of the army and navy in positions for which they are fitted. Technical men with several years of practical experience are now registered with the division, the record of each man being carefully investigated, and employers who are in need of such men are asked to inform us of the positions available, and only men well qualified for the positions will be sent to employers. As these facts are not generally known among employers, we take pleasure in giving publicity to the matter, and shall be delighted to be of service in aiding the good work. The engineering field appears at present the largest problem of the professional division, nearly one-half of the applicants being qualified for work in various forms of the engineering profession, particularly in steam and electrical engineering, embracing construction and operating work, and the American railways will continue to need such men probably as fast as they arrive from overseas.

Mountain Type Locomotives for the Atchison, Topeka & Santa Fe

In June of 1918, The Baldwin Locomotive Works completed two Mountain (4-8-2) type locomotives for the Santa Fe System. These engines, although differing somewhat in their construction, are generally similar in design; and they each exert a calculated tractive force of 54,100 lbs. They have the road numbers 3700 and 3701. The former is a coal burner and is equipped with Baker valve gear; while the latter is an oil burner, and is equipped with Walschaerts gear. There are a number of other differences in constructive details, to which reference will be made.

The two boilers are alike, apart from the changes incident to the use of different fuels. A conical ring is placed in the middle of the barrel, increasing the shell diameter from 82 ins. at the front end to 96 ins. at the throat. The firebox has a combustion chamber 45½ ins. long. Firebrick tubes are used in both the boilers, and the coal burning locomotive is equipped with an arch, and also with a power-operated grate shaker and firedoor. A Duplex mechanical stoker is applied. The standard arrangement of Santa Fe oil-burning equipment, with Booth burner, is used on engine 3701. The superheaters are of the same size as those used in the 3160 class of Mikado or 2-8-2 type locomotive in service on the Santa Fe.

Flexible stay-bolts are applied in the breaking zones in the sides, back and throat of the firebox, and in the sides and bottom of the combustion chamber; while four rows of expansion stays support the forward end of the combustion chamber crown. In the case of such of the expansion-stays as cannot be placed radially to the outside shell, bosses are electrically welded to the roof sheet in order to provide a sufficient number of threads for the stay-bolt sleeves.

The main dome is placed immediately in front of the combustion chamber, while the auxiliary dome is farther forward on the conical ring. This dome is placed on the left-hand side of the boiler, over a 17-in. opening, whose center is 14 ins. from the longitudinal boiler center. The opening thus clears the dry pipe, and permits easy entrance to the boiler for inspection or other purposes.

For locomotives of this capacity, the wheel diameter is comparatively large and the stroke is short. The proportions are such that excessive piston velocities will be avoided within the range of speeds at which these engines will run; while the excess pressure on the rail, due to the centrifugal effect of the counterbalance, is kept within reasonable limits by using comparatively light reciprocating and revolving parts made of special materials. The piston heads are steel castings of dished section, while the piston rods, main and side rods, and main crank pins, are of Nikrome steel. The piston rods are extended. The cross-heads interchange with those of the 3160 class Mikados, and are of the Laird type, with comparatively light bodies of 40 carbon steel. Fifty per cent. of the weight of the reciprocating parts is balanced. The driving-wheels are fitted with Mansell tire retaining rings.

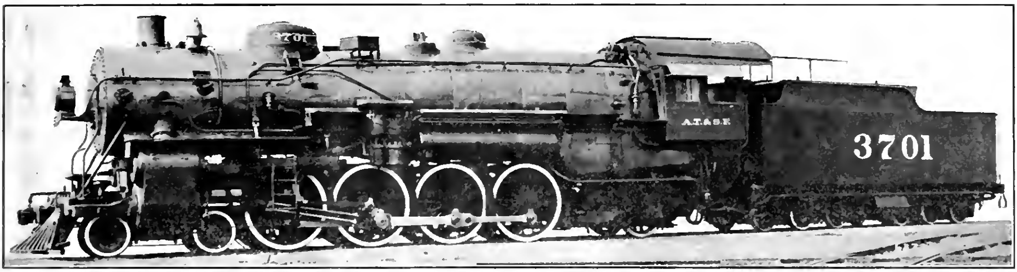
Locomotive No. 3700, with the Baker valve motion, is equipped with piston valves of the Santa Fe standard design and with the Ragonnet type "B" power reverse mechanism; while locomotive No. 3701, which has the Walschaerts motion, is equipped with the American Balance Valve Co.'s piston valves, and with the Lewis power reverse mechanism.

This device, which should be piped for compressed air or steam, consists of a reversing valve and a power cylinder, the piston of which is connected by a reach rod to an arm of the locomotive valve gear reverse shaft. The valve gear will be reversed from one full gear position to the other when the reverse lever is moved to opposite ends of the quadrant, regardless of the speed with which the lever is moved.

The reversing valve consists of a cast iron housing cast with integral arms to support the quadrant, and forms the fulcrum or pivot point for the eye or lower end of the reverse lever. Within the housing or casing, is a single rotary valve of brass, requiring but a small force to rotate it on the seat for the admission and exhaust of the compressed air or steam to and from opposite sides of the power cylinder piston.

The leverage obtained through the reverse lever and connections is much more than is required for the easy operation of the valve, but it is so designed to put the lever handle at the most convenient point within reach of the operator. The maximum stroke of the power cylinder piston is 18 ins., which may be adjusted between 15 and 18 ins. by means of the slotted rocker arm carried by the cylinder head bracket. Changing the pivot point of this arm by means of an adjusting screw in the rocker shaft does not necessitate blocking out any teeth in the reverse lever quadrant, the range of the reverse lever from full gear forward motion, to full gear backward motion, being constant, regardless of the maximum piston stroke secured through changing the ratio of the upper and lower arms of the rocker.

The running gear details include several features of interest. The main frames have a width of 5½ ins.; and the upper and lower frame rails, between adjacent pairs of the driving pedestals, are united by vertical ribs, which are cast in one piece with the frame and greatly increase its strength in a vertical direction. These ribs support the equalizing beam fulcrum pins. The frames are braced transversely at each pair of driving pedestals, and also midway between the pedestals. Long journals of the



W. B. Storey, Vice-Prest. MOUNTAIN OR 4-8-0 ENGINE FOR THE SANTA FE. Baldwin Locomotive Wks., Builders

"Cole" pattern are used on the second or main driving axle, and the shoes and wedges interchange with those of the 3160 class, Mikados. The rear frame is of the Commonwealth cradle pattern; and it is used, in this case, in combination with the Delta trailing truck. Locomotive No. 3700 is equipped with a leading truck of the Economy constant resistance type; while the leading truck of No. 3701 has three-point suspension swing links and a one-piece, cast steel frame in lieu of the built-up design of frame generally used.

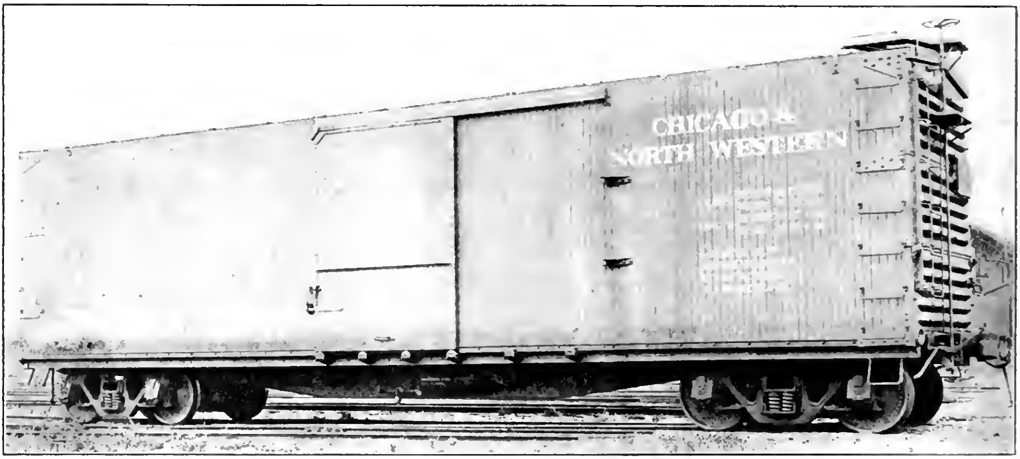
The guide-yoke and valve motion bearer of each locomotive are braced to the boiler by heavy wrought iron rods, which have jaws on their upper ends, and are pinned to brackets studded to the boiler shell. These brackets are fitted against external liners, which are riveted to the boiler. Ample strength is thus provided in a vertical direction, while provision is made for lateral movement due to the expansion and contraction of the boiler shell.

The tenders have six-wheel trucks and one-piece, cast-steel frames; and the details interchange with those of the Mikado type, previously mentioned.

Although these locomotives represent a type that is new to the Santa Fe System, and are in a certain sense experimental, their design is based on that of locomotives that are giving satisfactory results on this road, and no radically new features are embodied in their construction. Few railways in this country present more difficult operating conditions than the mountain divisions of the Atchison, Topeka & Santa Fe Railway, where there is an excellent field for demonstrating the capacity and efficiency of the Mountain type in heavy passenger service. Some of the principal dimensions are appended for reference. Cylinders, 28 x 28 ins. Valves, piston, 15 ins. diameter. Boiler, conical wagon-top type; diameter, 82 ins.; thickness of sheets, ¾ and ⅞ ins.; working pressure, 200 lbs.; fuel, oil; staying, radial. Fire box, material, steel; length, 122¼ ins.; width, 84¼ ins.; depth, front, 91½ ins.; depth, back, 77¼ ins.; thickness of sheets, sides, back and crown, ⅜ ins.; tube, 9/16 ins. Water space, front and sides, 5 ins; back, 4½ ins. Tubes, diameter, 5½ and 2¼ ins; material, the 5½-in. tubes are of steel, the 2¼-in. tubes are of iron; thickness, the 5½-in. ones are No. 9 W. G.; the 2¼-in. ones are No. 11 W. G.; there are 43 of the 5½-in., and the 2¼-in. tubes are 253; length, 21 ft. 0 ins. Heating surface, fire box, 243 sq. ft.; combustion chamber, 90 sq. ft.; tubes, 4,416 sq. ft.; firebrick tubes, 38 sq. ft.; total, 4,790 sq. ft.; superheater, 1,086 sq. ft.; grate area, 71.5 sq. ft. Driving wheels, diameter, outside, 69 ins.; journals, main, 12 x 20 ins; others, 11 x 12 ins. Engine truck wheels, diameter, front, 33 ins.; journals, 7 x 12 ins.; diameter, back, 47 ins.; journals, 9 x 14 ins. Wheel base, driving, 18 ft. 0 ins.; rigid, 18 ft. 0 ins.; total engine, 39 ft. 5 ins.; engine and tender, total, 76 ft. 8⅝ ins. Weight, on driving wheels, 227,700 lbs.; on front truck, 65,700 lbs.; on back truck, 60,500 lbs.; total engine, 353,900 lbs.; engine and tender, total, 567,600 lbs. Tender, 12 wheels, 33 ins. diameter; journals, 5½ x 10 ins.; tank capacity, water, 12,000 U. S. gals.; oil, 4,000 U. S. gals.

United States Box Car for the Chicago & North Western Railroad

The box car which we have the satisfaction of showing our readers this month —January, 1919, is a car built by orders of the United States Railroad Administration and allotted to the Chicago & North Western Railroad.



BOX CAR FOR THE CHICAGO & NORTH WESTERN RAILROAD.

It is a 40-ton capacity, double sheathed box car. Length inside, 40 ft. 6 ins.; width inside, 8 ft. 6 ins.; height inside, 9 ft. from the floor to under side of car lines; length over striking plates, 42 ft. 1½ ins.; width over eaves, 9 ft. 4 ins.; width over all, 10 ft. 2½ ins.; height from rail to top of eaves, 12 ft. 10⅛ ins.; height from rail to top of brake mast, 14 ft. 1¾ ins.; height from rail to top of running board, 13 ft. 6⅞ ins.; distance from center to center of trucks, 31 ft. 1½ ins.; height from rail to center of coupler, 2 ft. 10½ ins.

It is lettered on the side as follows: Cubical capacity, 3,098 cubic ft.; light-weight, 45,800 lbs.; nominal capacity, 80,000 lbs.; total weight, 132,000 lbs.; maximum load limit, 86,200 lbs. The car is well built so as to fully meet the United States Railroad Administration requirements embodied in specifications and drawings for a car of this class, in so far as the kinds and qualities of materials which are used. It is equipped with the

Murphy X L outside galvanized roofing, furnished by the Standard Railway Equipment Co. The ends of the car are of the Murphy corrugated design, handled by the Standard Railway Equipment Company and manufactured by the car builders, the American Car and Foundry Co. The draw bars are M C B type D, 6 x 8 ins. shank. The draw gear is the Sessions Standard Platform and Coupler Co. type. The air brakes are the Westinghouse K C 10-12. The angle cock supports are the special design of the Western Equipment Co. and center sills are the fish belly type with cover plates. The body bolsters are built up of pressed pan-shapes with upper and lower cover plates. Safety appliances are in accordance with United States requirements. The truck sides are the Anddews type, cast steel, manufactured by American Steel Foundries. The truck bolsters are made of cast steel, United States Standard design, and the brake beams are Simplex, Master Car Builders No. 2. The oil boxes are malleable iron, manufactured by National Malleable Castings Co. The side doors and uncoupling device is that from Standard Railway Equipment Co. The side doors are manufactured by Union Metal Produce Co., and the uncoupling levers by the Material Appliance Company.

Some railways are not favorable to a double sheathed box car and it is often said that this is based on the following and other reasons, but the C. & N. W. car, which we illustrate here is a single sheathed car. A car of the double sheathed kind with steel underframe and sides sufficiently strong to prevent bulging, causes additional weight and strength to be put in the side framing of the car, which tends to increase the weight of a car built of such height as all these standard cars are, goes beyond that which is justifiable for a car of 80,000 lbs. capacity. The lower ends of posts and braces on a double sheathed car must necessarily be secured to the side sill or side sill framing in such a manner as to be somewhat insecure when compared with the more secure manner in which a car of the single sheathed type can have posts and braces secured to the side sill construction. The manner in which a double sheathed car has the siding secured to the frame by nailing on the outside with all internal pressures against it, tends to force it away from the frame and trouble has often been occasioned with cars of this class in having the sheathing or siding come loose from the frame. The floor in this car is 2¾ ins. in thickness and is not supported between the center sill and the side sill. The single sheathed car, here illustrated, is a serviceable vehicle and will no doubt give a good account of itself. It has a good businesslike appearance.

The general dimensions are as follows: Length inside, 40 ft. 6ins.; width inside, 8 ft. 6 ins.; height inside, 9 ft.; length over striking plate, 42 ft. 1½ ins.; width over eaves, 9 ft. 4 ins.; width over all, 10 ft. 2½ ins.; height from rail to top of car eaves, 12 ft. 10⅛ ins.; height from rail to top brake mast, 14 ft. 1¾ ins.; height from rail to top running board, 13 ft. 6⅞ ins.; distance center to center of trucks, 31 ft. 1½ ins.; height from rail center of coupler, 2 ft. 10½ ins.; height from rail bottom of center sill, 2 ft. 4½ ins. This car has full, all-steel underframe, with fish-bellied center sills; steel reinforced superstructure, and is equipped with three-section corrugated, horizontial steel ends. It is also equipped with Carmer coupler release rigging, friction draw gear, and key connection coupler to draw gear, and the trucks are equipped with anti-friction side bearings. The material and construction may be said to be of the best.

Development and Construction of Standard Couplers

Among the various mechanical appliances that have been introduced and perfected during the last thirty years of railroad experience, there is probably none that has represented the amount of detail work that has been performed by various committees of the Master Car Builders' and Master Mechanics' Associations. Beginning in 1888, efforts were made to establish a standard contour line on the coupler. From 1890 to 1899 gauges extending the various dimensions were ordered. This was inevitable owing to the constantly increasing weight of motive power and increase of tractive power. Underneath unlocking devices operating with an upward movement are of comparatively recent origin. Details of methods and results of tests involved much outlay of expensive experiment. Striking plates and other devices of sufficient strength to avoid deformation had to be applied, and even in these lesser details the variety of opinions had to be clarified by experience and submitted to the usual test of letter ballots, which has been found to be a convenient method of solving disputed questions, and very helpful in guiding the various committees to popular conclusions.

As may be readily imagined the manufacturers were not idle in presenting their rival claims to superiority, and even with the slight variations in parts, all of which even admitted to possess some particular merit, there was no end of confusion occurring when collisions sufficiently forceful to distort the coupler, and no other coupler could be applied except one of that particular design which was not always at hand. A book could be filled describing these disasters, and it would make good reading, as showing the absolute need of standardization of mechanical appliances.

Out of this maelstrom of mixed mechanism perhaps the most important committee engaged in the wearisome work was appointed, and after four years of experimenting, and compromising, the Committee were led to adopt what is known as type "D" coupler. This was selected at Altoona, Pa., by a committee of the M. C. B. Association in May, 1916 R. L. Kleine, of the Pennsylvania Railroad, was chairman of the Committee, and his untiring zeal in the work was the theme of universal praise among all who knew of his intelligent activity in the work. He was ably assisted by his co-workers, whose names are a guarantee of their capabilities embracing as it did such experienced engineers as G. W. Wilden, F. W. Brazier, F. H. Stark, J. W. Small, A. E. Manchester and J. A. Pitcher.

The Committee admitted their obligations to the coupler manufacturers who worked jointly with the Committee, and particularly tc the American Steel Foundries and the National Malleable Castings Company for their testing apparatus, which they furnished together with operators, gratis, and to J. T. Wallis, general superintendent motive power, for the testing facilities, couplers, material and expert assistance furnished to carry out the tests and investigations, also to the New York Central Railroad for the test couplers furnished, and also to the Railway Supply Men's Association for valuable spaces for the various exhibits of the results of the experiments.

It may be added that during the period in which the experiments were conducted under the supervision of the Committee, the Manufacturers Association spent over $200,000 in assisting in the work of the Committee and the railroads spent $100,000 approximately, in carrying on the work.

The benefits that have already accrued to the railroads of the country as the result of the adoption of a standard are so far-reaching and important that the leading manufacturers recognized that the immediate interests of the individual coupler manufacturer should be subordinated thereto, and the following firms made announcements that they had promptly provided complete equipment of flasks, patterns, core-boxes, gauges, and other essentials to supply the require-

ments of the railroads with the new coupler in large quantities: American Steel Foundries; the Buckeye Steel Castings Company, Gould Coupler Company, the McConway & Torley Company, Monarch Steel Castings Company, and the National Steel Castings Company.

The standard coupler, as is well known, weighs approximately 400 lbs. It represents an increase in weight over the old types of 33 1/3 per cent., and has brought about 100 per cent. increase in strength with the material remaining unchanged. The inspection of the couplers has also

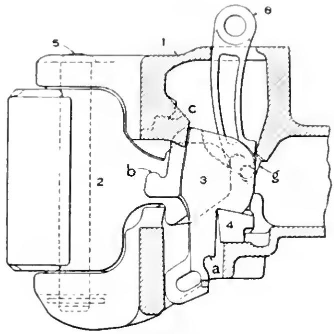


FIG. 1.

been centralized by the creation of a General Inspection and Test Bureau for all the railroads. This is under the control of the Master Car Builders' Association. This has admitted of the employment of inspectors exclusively on this class of work, who are familiar with coupler requirements to a degree not possible in the care of inspectors from the test departments of various railroads, in-

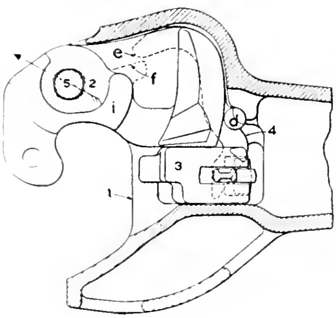


FIG. 2.

specting a great variety of material. In this way the cost of inspection is reduced to a minimum.

In regard to the design and distribution of gauges and masters, the specifications require that they are to be used not only for the complete coupler, but also for the different parts. In this way there will be no doubt as to the interchangeability, proper fitting, and operation of the coupler. These gauges have been submitted by letter ballot and were adopted in August, 1918, the result, generally speaking is, that the standard coupler, is not only the best hitherto manufactured, but it is possible to produce the coupler at a lower cost than could have been under any other conditions.

Coming to the details of the operation of the standard "D" coupler, they are shown as arranged for top operation in Figs. 1 and 2. The essential parts are the body 1, knuckle 2, lock 3, knuckle thrower 4, and knuckle pin 5, each of which, except the body, remains unchanged for either type of operation. When equipped for tip operation the lifter 6 is used, and when in locked position, as in Fig. 1, the lock rests upon the top of one end of the knuckle thrower 4, and its head is located between the knuckle tail and inner guard arm wall as shown in Fig. 2. To lockset the lock it is lifted by the top of lifter 6, until lockset *a* on the leg of the lock becomes level with the top surface of the knuckle thrower, whereupon the leg of the lock tips rearwardly and seats upon the knuckle thrower. In either top or bottom operating forms the lock is lifted at a point to the rear of its center of gravity so that there is always a tendency for the leg of the lock to swing rearwardly as soon as the lock is lifted. To throw the knuckle the lock is lifted, above its lockset position until the fulcrum *b* upon its forward side strikes the shoulder *c* within the coupler head. The vertical movement of the lock is stopped by this contact, and the lock is thereafter freed to rotate about its fulcrum, which gives the lock leg a positive rearward movement, which in turn rotates the knucle thrown about its trunnions *d*. The tip *e* of the thrower contacts the shoulder *f* on the inside of the knuckle and and throws the knuckle open.

The lock-to-the-lock or anti-creep function is obtained in the top operated form by the co-operation of the lock lifter with the rear wall of the coupler head as shown in Fig. 1. When the parts are locked the lifter slides rearwardly in the lock until its projection *g* underlies the lower edge of the rear wall of the coupler head. Any upward movement of the lock merely binds this projection between the lock and the rear wall. As soon as the lifter itself is raised, however, it slides forward and upward in the lock and frees its anti-creep engagement.

The forward pull upon the knuckle in draft not only pulls the knuckle directly forward against the pulling lugs, but also tends to force the knuckle laterally in the direction of the arrow in Fig. 2. To resist this lateral pressure the knuckle is provided upon top and bottom with outwardly extending "pin protector lugs," which enter correspondingly shaped recesses in the upper and lower walls of the coupler head. In order to relieve the knuckle pin of the greater part of the pulling and buffing stresses the knuckle pinholes in the pivot lugs of the coupler are elongated slightly as shown in Fig 2, allowing the knuckle to take a firm bearing within the head in pull or buff stressing the knuckle pin.

Fig. 3 is a view of the coupler from the front of the guard arm side, and Fig. 4 is a view of the locomotion coupler adopted as the United States Government standard design.

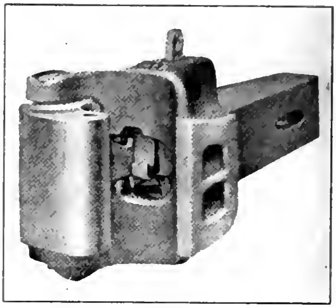


FIG. 3.

We do not deem it necessary at this time to describe the unimportant details of the coupler intended for bottom operation. A reversion of the lock lifter and toggle are applied with the same effect in the movement of the parts, and a cap covering for the lifter 6 and lugs is provided, forming a bearing for the lifter.

Such are, in brief, a history of the development and description of the stand-

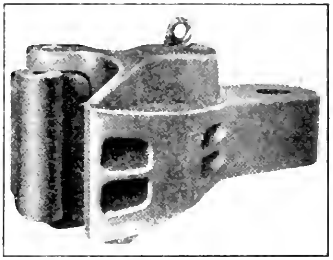


FIG. 4.

ard coupler, a device which in point of safety and reliability is one of the most important mechanical contrivances of our time, and the benefits to the railways of the country which have already resulted, and undoubtedly will continue to result, from the adoption of the new standard of the M. C. B. Association, are so far-reaching and important that it is already a matter of satisfaction that all are agreed that the difficulty of standardizing the coupler has been completely accomplished.

Chicago, Milwaukee & St. Paul Railway Test of Locomotive Equipped with the Nicholson Thermic Syphons

In order to determine the merits of this device, engine 7615 was equipped with two Nicholson Thermic Syphons and tested in road service against engine 7142 of same class equipped with a standard arch, supported on arch tubes. Both engines had recently undergone shopping for heavy repairs. In order to avoid all possible error in coal and water weights, the same tender, of known calibration, was used in all tests. The weather conditions were good and uniform throughout the tests.

The locomotives tested used saturated steam, consolidation type, with piston valves and Walschaert valve gear, and alike in all respects, except that the firebox of 7615 was equipped with the Nicholson Thermic Syphons supporting the brick arch, while engine 7142 had the ordinary type of arch supported on four 3-in. arch tubes. The principal dimensions and data are given below:

TABLE NO. 1.

COAL CONSUMPTION.

1 Eng. No.	2 Test No.	3 Total Lbs. Coal Fired	4 Average Lbs. Coal Fired Per Hr.	5 Lbs. Coal Per Hr. Per Sq. Ft. of Grate	6 Lbs. Coal Fired Per 100-Car Mile	7 Lbs. Coal Fired Per Locomotive Mile	8 Lbs. Coal Fired Per Gross 1000 Ton Mile
7615	1-E	18400	3262	66.84	382.8	206.7	80.60
	2-W	20450	3903	80.00	689.0	222.7	102.84
	3-W	20820	3523	72.19	513.7	226.8	101.35
	4-E	19505	3744	76.72	317.6	219.1	91.61
	Ave.	19794	3599	73.75	440.6	218.9	93.64
7142	1-W	29450	4558	93.40	486.0	320.8	162.12
	2-E	22100	4300	88.11	483.9	248.3	108.22
	3-W	25855	4568	93.60	638.1	281.6	141.51
	4-E	20930	4120	84.42	461.1	235.1	94.10
	Ave.	24584	4401	90.18	510.8	271.9	124.36

LOCOMOTIVE DATA.

	Eng. 7615	Eng. 7142
Cylinder, diameter and stroke	23 x 30 ins.	23 x 30 ins.
Drivers, diameter	63 ins.	63 ins.
Tractive power, lbs.	42,800 lbs.	42,800 lbs.
Weight on drivers	190,400 lbs.	189,200 lbs.
Total weight of engine	216,900 lbs.	215,700 lbs.
Total weight of engine and tender	351,450 lbs.	350,250 lbs.
Boiler, type	Straight R. S.	Straight R. S.
Boiler, diameter, first course	75¾ ins.	75¾ ins.
Grate area, sq. ft.	48.8	48.8
Tubes, number and outside diameter	414—2 ins.	418—2 ins.
Tube, heating surface	3,143.0 sq. ft.	3,173.4 sq. ft.
Normal firebox heating surface	195.7 sq. ft.	195.7 sq. ft.
Heating surface added by arch tube	....	29.3 sq. ft.
Heating surface added by thermic syphon	53.0 sq. ft.	....
Total firebox heating surface	248.7 sq. ft.	225.0 sq. ft.
Total heating surface	3,391.7 sq. ft.	3,398.4 sq. ft.
Total heating surface ÷ grate area	69.5	69.6
Firebox heating surface ÷ total heating surface	7.3 per cent.	6.6 per cent.
Firebox heating surface ÷ grate area	5.1	4.6

An elevation and cross-section of the firebox of engine 7615 is shown in Fig. 1. The two test fireboxes are of the same dimensions throughout, the only differences being those noted above.

The tests were run between Milwaukee and Portage. In the following tables the letter "W" following the test number indicates that the run was west-bound, from Milwaukee to Portage, while the letter "E" indicates that the tests were east-bound.

No attempts were made to control the make-up of the test trains other than limiting the tonnage to what the engines could handle over the ruling grade. Table No. 1 shows the coal consumption, column three showing the total pounds of coal fired while train was in motion.

No attempt was made to select coal for the tests, the engines being coaled up at the chutes at each end of the run, taking the coal as it came.

Table 3 gives the actual coal fired per hour and water evaporated during the different tests. The factor of evaporation shown in column nine is too high, owing to the fact that no correction was made for moisture in steam; but the values given are quite comparable.

Column eight, Table No. 3, shows the average boiler pressure maintained during the different tests. There was very little difference in this respect between the two locomotives, as both were free steamers; but it was noticeable that the boiler of engine 7615 was more responsive to the demands made upon it than that of engine 7142.

During the course of the tests some 475

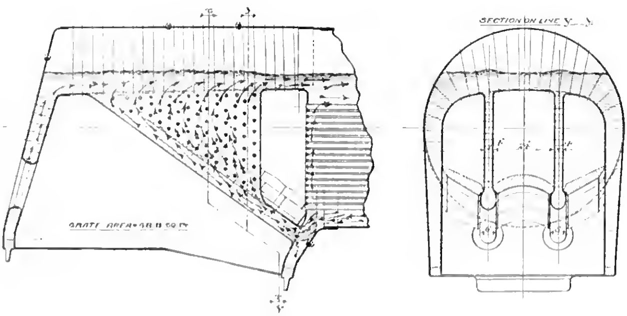


FIG. 1. SECTIONAL VIEW OF BOILER WITH NICHOLSON THERMIC SYPHON.

readings were taken of the boiler pressure of engine 7615, and of these only 19 showed a pressure below 195 pounds, the pop valves being set at 204 pounds.

Full steam pressure could be maintained without trouble against both injectors when engine 7615 was working its hardest on grades.

Table No. 4 shows the equivalent evaporation, boiler horse power and efficiency, the boiler efficiency being based on the heat in the coal as fired.

TABLE NO. 2.

COAL ANALYSIS—COAL AS FIRED.

1	2	3	4	5	6	7	8
Eng. No.	Test No.	Moisture	Volatile Combustible	Fixed Carbon	Ash	Sulphur	B.T.U. Per Lb. Coal
7615	1-E	10.00	39.70	42.33	7.97	3.213	11789
	2-W	10.00	31.97	39.78	18.25	4.023	9671
	3-W	10.00	35.00	35.96	19.04	3.498	9799
	4-E	10.00	33.84	37.26	18.90	4.580	9622
	Ave.	10.00	35.02	38.75	16.23	.....	10184
7142	1-W	10.94	36.20	40.39	12.47	4.775	10593
	2-E	9.00	37.67	39.70	13.63	4.658	10954
	3-W	11.11	38.19	40.65	10.05	4.349	11143
	4-E	9.36	37.66	42.69	10.29	4.664	11184
	Ave.	10.21	37.36	40.80	11.63	.....	11008

TABLE NO. 3.

BOILER PERFORMANCE—COAL AND APPARENT EVAPORATION.

1	2	3	4	5	6	7	8	9
Eng. No.	Test No.	Lbs. Coal Fired Per Hr.	Lbs. Water Evap. Per Hr.	Lbs. Water Evap. Per Lb. Coal	Lbs. Water Evap. Per Sq. Ft. Heat. Surf.	Temp. Feed Water	Average Boiler Pressure	Factor of Evap.
7615	1-E	3262	21782	6.68	6.42	49°	198.3	1.2187
	2-W	3903	23553	6.04	6.94	52°	199.2	1.2149
	3-W	3523	22825	6.48	6.73	52°	198.9	1.2149
	4-E	3744	23589	6.30	6.95	51°	198.4	1.2159
	Ave.	3599	22912	6.36	6.75	51°	198.7	1.2159
7142	1-W	4558	23707	5.20	6.97	50°	198.8	1.2170
	2-E	4300	24554	5.71	7.22	54°	198.3	1.2129
	3-W	4568	23394	5.12	6.88	58°	196.6	1.2086
	4-E	4120	23338	5.66	6.88	52°	197.6	1.2149
	Ave.	4401	23728	5.39	6.98	53°	197.9	1.2139

TABLE NO. 4.

BOILER PERFORMANCE—EQUIVALENT EVAPORATION HORSE POWER AND EFFICIENCY.

Eng. No.	Test No.	Equivalent Evaporation—From and at 212° F. Lbs. Per Hr.	Per Hr. Per Sq. Ft. Heat. Surf.	Per Lb of Coal as Fired	Per Lb. of Dry Coal	Per Lb. of Combustible	Boiler Horse Power	Boiler Efficiency
7615	1-E	26546	7.82	8.14	9.04	9.42	769.4	67.00
	2-W	28615	8.43	7.34	8.14	10.22	826.5	73.63
	3-W	27730	8.16	7.87	8.74	11.09	803.7	77.96
	4-E	28682	8.45	7.66	8.51	10.77	831.3	77.26
	Ave.	27858	8.21	7.74	8.60	10.49	807.4	73.75
7142	1-W	28851	8.48	6.33	7.10	8.26	836.2	58.00
	2-E	29781	8.76	6.93	7.35	8.95	863.2	61.35
	3-W	28274	8.31	6.19	6.96	7.85	819.5	53.89
	4-E	28353	8.34	6.88	7.59	8.56	821.8	58.10
	Ave.	28803	8.47	6.54	7.28	8.37	834.8	57.65

Table No. 5 shows the draft in front end, firebox, and ash pan, also the front end temperatures secured during one round trip of each locomotive. The draft readings were obtained while double nozzles 3½ ins. in diameter were in use. The nozzles of the 7615 were opened up to 3-11/16 ins. in diameter, during the last round trip and effected some reduction in the draft readings.

The front end temperatures were obtained by means of a Hoskins pyrometer attached to a recorder from which the temperatures in degrees Fahrenheit were read. The wires of the hot couple of the pyrometer were about 0.2 ins. in diameter and for wires of this size there is always a considerable radiation loss, resulting in temperature readings that are too low. It is estimated that on this account the temperature readings of engine 7615 were about 22 degrees too low, and those of 7142 about 26 too low, and in calculations front end temperatures of 550 degs. Fahr. for engine 7615 and 625 degs. Fahr. for engine 7142 were used.

As no analyses were made of the front end gases it is impossible to tell exactly what changes in combustion conditions were brought about by the introduction of the Thermic Syphons.

The marked reduction in fuel consumption and increase in boiler efficiency shown in the tables warrants some explanation, for it is evident that a mere increase in firebox heating surface of some 23.7 sq. ft. is not of itself sufficient to cause such a showing. The improvement is due rather to the shape and location of the syphon and the arrangement of its heating surfaces with respect to the flame contents of the firebox.

The reduction in the front end temperatures indicates that the firebox of engine 7615 absorbed a greater portion of the total heat generated than did the firebox of engine 7142. The amount of water evaporated by each of these fireboxes can only be determined accurately by actual and rather expensive tests but it can be approximated in the following manner:

Knowing the temperatures of the gases entering the flues at the firebox end, the temperature of the gases leaving the flues at the front end, and the weight of the gases passing through per hour, the evaporation from the flue heating surfaces can be obtained. This amount subtracted from the total evaporation will give the firebox evaporation.

As no front end gas analyses were made, the amount of air supplied per pound of coal fired is unknown; but under similar conditions as to grade of fuel, rate of combustion and type of grates, numerous locomotive test plant records indicate an average air supply of 10½ lbs. of air per pound of coal at the rate of combustion of 73.75 lbs. of coal per square foot of grate per hour, for engine 7615, and

TABLE No. 5.

DRAFT AND FRONT END TEMPERATURE.

Engine No.	Test No.	Lbs. Coal Fired Per Hour.	Lbs. Coal Fired Per Sq. Ft. Grate Per Hour.	Draft—Inches of Water.			Front End Temp.
				Front End.	Firebox.	Ash Pan.	
7615	1-E	3262	66.84	5.2	1.67	.27	520°
	2-W	3903	80.00	5.3	1.66	.29	536°
	Ave.	3582	73.42	5.25	1.66	.28	528°
7142	1-W	4558	93.40	5.3	1.56	.22	610°
	2-E	4300	88.11	5.0	1.27	.17	589°
	Ave.	4429	90.15	5.15	1.41	.195	599°

9.75 lbs. of air per pound of coal at the rate of combustion of 90.18 lbs. for engine 7142. Assuming this amount of air to be approximately correct, we can determine the weight of gases passing through the flues per hour for the two locomotives.

Knowing the front end temperatures and the weight of gases passing through the flues, the temperature of the gases entering the flues, can be approximated by means of an empirical formula devised by Professor Fessenden, and based upon the results of numerous tests made at the University of Missouri, and having determined the temperature of the gases entering the flues, and knowing the temperature of gases leaving the flues and the weight as shown by figures, the firebox evaporation of engine 7615 was approximately 5,100 lbs. per hour greater than that of engine 7142, while the flue evaporation was 6,050 lbs. an hour less in engine 7615 than in engine 7142. High firebox evaporation accompanied by a reduction in flue evaporation, results in higher overall boiler efficiency. The reason is that the firebox heating surfaces can be worked at a high rate of evaporation with very little decrease in efficiency, while the efficiency of the flues decreases rapidly as their rate of working is increased.

Short flues, such as the 14½ ft. flues in these engines, were of advantage; the only disadvantage being the higher temperature at which they generally discharge the gases. The data obtained in these tests indicates that an installation of heating surfaces, such as is obtained by the use of the Nicholson syphon, will result in such a great increase in absorption of heat in the firebox that the flues will have correspondingly less work to do; will work with increased efficiency and will discharge the gases at the front end at a much lower temperature.

Short flues give greater activity of combustion and of evaporation than long flues, and when used in conjunction with syphons, high overall boiler efficiency is obtained with low front end temperatures, which removes the only advantage claimed for long flues.

Equivalent evap. from firebox, lbs. per hour—Eng. 7,615 ....=	15,106 lbs.
Equivalent evap. from firebox, lbs. per hour—Eng. 7142 ....=	10,003 "
Increase in equiv. evap. from firebox of engine 7615, presumably due to syphons.=	5103 "
Syphon heating surface two syphons ....=	53 sq. ft.
Water evaporated by syphons per hour.......=	78 cu. ft.
Total water entering syphons per hour........=	4,616 "
Cubic capacity of boiler with two gauges of water.....=	382 "

Time required to calculate all the water in the boiler, 5 minutes.

With such high velocity of circulation and with such large volume of water syphoned through the inlets in such a short space of time, it is apparent that no cold water could collect in the belly of the boiler, or remain there for any length of time. The syphons are located so as to take advantage of the natural trend of circulation in the boiler and give greatly added velocity to it. The cold water fed in finds its way to the bottom of the boiler and slowly travels back towards the firebox. The syphons draw their water supply from this ordinarily cold zone at such a rapid rate that the cold water fed in is quickly drawn back to the throat and syphoned through the hottest zone of the firebox where it is heated up to the temperatures of the steam and partly evaporated. The water at steam temperature discharged from the top of the syphons, travels forward toward the front flue sheet thereby tending to draw the cold water up from the bottom of the side and back water legs. Under these conditions of circulation, the water is maintained at a nearly uniform temperature throughout the boiler, and this should result in a marked decrease in the prevalent boiler troubles due to the unequal contraction and expansion caused by wide variations in the temperature of the water in different parts of the boiler.

As a sort of summary, we may say that Engine 7615 equipped with the syphons showed an actual fuel saving of 5,000 lbs. per 100 locomotive miles while hauling 150 tons more than engine 7142. On a basis of 27,000 locomotive miles per year this means a saving of 750 tons of coal per year per locomotive, or a saving of $3,000 per year with coal at $4.00 per ton on the tender. The same percentage of saving on a heavier and larger locomotive, it is reasonable to suppose, would result in a greater saving in tons of coal and in dollars and cents. A considerable portion of the fuel consumed by locomotives is used in firing up, and while no tests have yet been made, the indications are that locomotives equipped with the Nicholson Thermic Syphons will require less coal for firing up.

The gross saving effected by the syphons, it is also stated, will be reduced by a comparatively low cost of application and by a low maintenance cost that can be accurately determined only by experience. The method of construction and application makes the syphon an integral part of the firebox, that requires no more attention than any other part.

The indications are that the vigorous circulation obtained will result in keeping all parts of the boiler and firebox at a much more uniform temperature, and will reduce the troubles caused by unequal expansion and contraction both in the firebox and in the flues.

It is further claimed that three months of service has revealed no trouble from mud or scale. The high circulation through the syphons has resulted in keeping them swept clean at all times; and seemingly has thrown most of the mud and scale over into the back water leg where it settles down to the bottom and is easily accessible for removal. Up to the present time there has been no evidence of scale in the syphons; nor leaks of trouble of any sort from seams or stays.

It is only fair to say that, while most highly commending Mr. H. R. Warnock, General Superintendent of Motive Power of the Chicago Milwaukee & St. Paul Railway, in his effort, here detailed, for the advancement of locomotive operation, the test, though carefully made, has been carried out on a non-superheated locomotive, and to that extent the test is not absolutely convincing, though it is more than extremely probable that other tests will confirm what has been so skilfully accomplished. It is also said that unless the brick arch was present in the syphon locomotives a good deal of their efficiency might have been nullified.

The tests however mark a decided step in advance in the art of boiler construction, and one that will not be in any sense a "flash in the pan." The way for progress has been opened and it is certain that trial and use will enter in, in large measure, until finally full fruition will crown these efforts. Mr. Warnock has had the courage of his convictions and if he has succeeded, he has even now the pleasing satisfaction of knowing that his efforts from one more forward step in the harnessing of applied science to one of the most important phases of locomotive development and efficient boiler construction

Lima Locomotive in Switching Service

With the Tennessee Coal, Iron and Railway Company

The Lima Locomotive Works, Inc., of Lima, Ohio, has recently delivered what is known as a Shay engine to the Tennessee Coal, Iron and Railway Company. The engine is at work at the Fairfield plant in Alabama, and this latter concern is a subsidiary of the T. C., I. & R. R. Co. The engine was delivered in November, 1918, and was put in operation at once, and has been continuously working since then, and has given the users every satisfaction.

The work which this engine is doing is handling all the standard railway cars and material that is put behind it, irrespective of weight or capacity, and is also doing all the work with the crane for loading and unloading structural steel and machinery. In this work it has the distinct advantage, in view of the ease with which it will start and stop, of accurately spotting a crane at the correct position. It is the fact of rapid stop and start, that makes the Shay engine good at switching. It can move quickly and stop short, so that loss of time is eliminated and its consequent ability to "spot" cars or cranes makes it particularly serviceable for railway switching and for working in industrial plants.

There is a lot of rubbish and building material around the tracks where this engine works, yet the "Shay" has been able to operate without trouble, the gearing on this engine being high enough to not interfere with broken pieces of timber or scrap structural shapes, which are lying about, and as a matter of fact it goes about its business on very rough track, which is laid down quickly and which might cause a more orthodox switcher much difficulty to negotiate.

The engine is operated on fuel oil, and has a one-man control; that is, the oil control handle is on the right hand side of the cab, easily accessible to the engineman. While there are no accurate figures as to the speed which this locomotive will make, yet it is quite safe to say, as we are informed on good authority, it is 20 miles an hour, and this, with the absence of vibration or excessive noise.

From observation it has been noticed that this engine is very economical on oil and water, burning only about 300 gals. of oil per ten-hour day. Both the engineman and fireman were unfamiliar with the Shay locomotive and its operation when it was placed in service at Fairfield, but the representative of the Lima Locomotive Works was able in a very short time to impart the necessary information to the crew which was assigned to this engine.

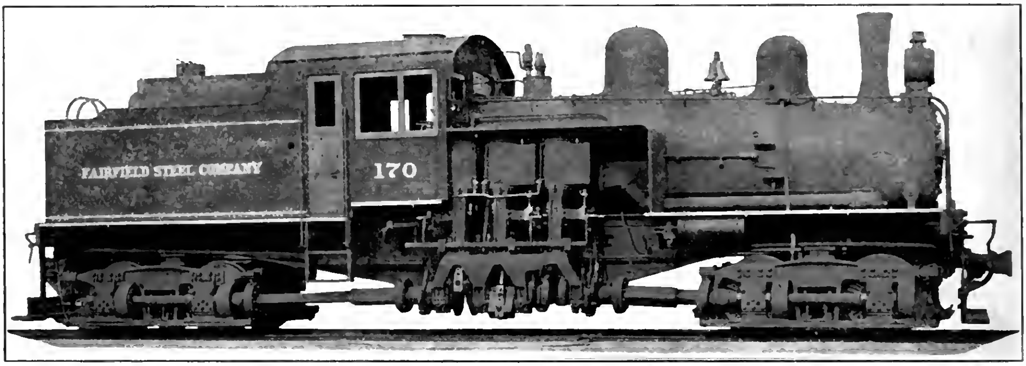
The boiler is of the extended wagon-top type, and is radially stayed. The largest boiler course is 64 ins. in diameter, and the waist goes 55 ins. at the front end. The boiler is built with a factor of safety of 5, and carries 200 lbs. pressure. This means that the boiler will stand an ultimate internal pressure of 1,000 lbs. before it begins to show signs of distress. The throat sheet is 11/16, the roof and sides are 9/16, the back head and the tube sheet are ½ in. thick. The horizontal seams are triple butt riveted and the circumferential seams are double lap riveted. Machine riveting is the rule. The tubes are made of steel, thickness No. 11 B. W. G. 2 ins. in diameter, and there are 210 of them, each measuring 11 ft. 0 ins. long, spaced in vertical rows.

The fire-box has a sloping, arched crown-sheet 72½ ins. long and 50¼ ins. wide. The crown, sides and back sheets are ⅜ in. thick. The fire-door is elliptical for convenience in firing. The water spaces are ample, being front 4 ins. and the sides and rear are 3½ ins. wide. The crown-sheet is held up by 15/16 in. stays, with ends measuring 1⅛ ins. in diameter. The two front rows are Tate expansion stays. The engine burns oil fuel and is fitted with suitable firebrick and burner. The dome is placed somewhat in front of the fire-box. The smoke-box is made so that the front section, which is separate from the rear section, shall contain the draft appliances. The fuel burning apparatus includes a Von Boden burner with operating valves, heater and blower, so placed as to be operated from the right side of the cab. The fire-pan is made of steel with suitable dampers and air inlets. The boiler is covered with asbestos cement lagging as well as the dome.

The glass water gauge is one of the Reflex type. There are two safety valves 2½ ins. diameter each.

The frame is of special design, with heavy girders and is composed of structural steel and built up with plates. There are in all corners angles, riveted and braced with heavy lateral braces at the front and rear of the boiler. The frames are protected by cast steel bumpers, front and back. Center plates of cast steel are used, having 18 in. machined seats.

The cylinders are three in number, placed vertically, they are made of iron and are attached to brackets, so arranged as to allow for expansion. They are 13 x 15 ins. and are lubricated by a Detroit four-feed lubricator. The piston rods are hammered steel, 2¾ ins. in diameter. Lima metallic packing is used on the rods and Garlock on the valve stems. The crossheads have a taper fit to the piston rods with keys and are made of cast steel. The shaft is solid forged steel

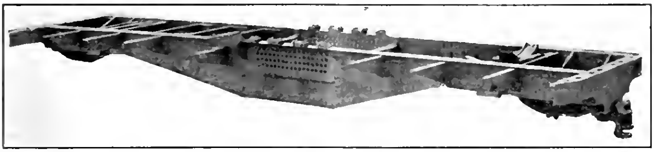


LIMA GEARED LOCOMOTIVE USED IN INDUSTRIAL SWITCHING.

Fairfield Steel Company. Lima Loco. Wks., Builders.

5 ins. in diameter, with crank-pin journals 6 ins. in diameter and 5 ins. long.

The engine and tender trucks of this engine are two independent, centre bearing swivel trucks with four 40-in. wheels. The top bolster a 12 x 35 3/8 ins. channel, and the bottom bolster is 10 x 35 3/8 ins.



VIEW OF FRAME OF LIMA GEARED LOCOMOTIVE.

The gear rims are cast steel, firmly bolted to each right hand driver of the engine, and there are keys inserted between the gear rims and wheel centers, to relieve the bolts from shear. The pinion shaft is 5 ins. in diameter, front and rear, with steel pinions pressed and keyed on. The journals are 14 ins. long, with bronze bearings. There is a steam-operated bell ringer on the engine.

The tank plates are 3/8 in. thick, while the top and bottom plates are 1/4 in. The water capacity is 3,000 gals. and 1,500 gals. of oil. Some of the principal dimensions are as follows: Track guage 4 ft. 8½ ins., rail 90 lbs. per yard. Maximum grade 4 per cent. Maximum curve 75 ft. radius. Height of engine to top of rail 13 ft. 9 ins. Total wheel base 35 ft. The extreme width from centre of track at 21 3/4 ins. above rail is 56 1/4 ins. The rigid wheel base is 5 ft. 0 ins. Weight in average working order 144,000 lbs. Tractive power 32,480 lbs. Factor of adhesion 4.43, gear ratio 1 to 2.28. Fire-box heating surface 118 sq. ft. In the tubes there are 1,200 sq. ft. Total 1,318 sq. ft. Grate area 25.7 sq. ft. Pinions have 18 teeth and the gear rims have 41 teeth. A steam brake is used, so that the natural quickness of the stop and start is considerably augmented. Some steam railways are beginning to use these geared Lima locomotives in heavy, quick switching serviee, and the practice is likely to grow as their adaptability is excellent.

Force Feed Lubricator

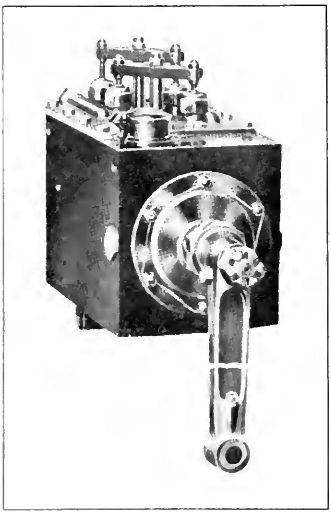
Records Showing Marked Degree of Economy

The Schlacks system of Force Feed Lubrication, as applied to locomotives, is handled by the Locomotive Lubricator Company of Chicago. It was formerly the McCord Company. This force feed is simply a small pair of pumps worked by the moving parts of the engine and handling oil. The pumps operate when the engine is going and they stop when the engine comes to a standstill. That is the principle in a nutshell.

The aim of good lubrication is the reduction to a minimum of all friction. It is evident that this, a loss of power of a locomotive, must be considered primarily in connection with the cost of maintenance, operation and delays, and friction is just such a loss. A device which needs no attention, reaches a high degree of efficiency and economy, in that it is measured, not per unit of time, but per unit of work done.

The lubricator lever is operated by a link connected to the locomotive valve gear. This operates a ratchet which turns a cam-shaft in a reservoir that holds approximately eight pints of valve oil. Two pumps, one for each steam pipe, delivers oil from the reservoir into the steam at every revolution of the driver. The reservoir is attached to the back head of the left valve chamber.

This system does not have to be started fifteen minutes before the engine moves. It delivers oil, in proportion to the steam consumption, the instant the engine starts and when it is running. There is nothing to turn on or off before starting or after stopping or before or after filling, summer or winter. There is no feed regulation and nothing to adjust. The lubricator is not in some choice position in the already crowded cab, where the greatest fall can be had. Nor need it be equipped with a special light for convenience of examination. Oil is injected into the steam pipe, sufficiently in the rear



FORCE FEED LUBRICATOR.

of the valve to permit of the oil being thoroughly mixed in the steam, so that, if a little steam is used in drifting, oil impregnated steam such as that which lubricate the valves, also lubricates the cylinders. There is no such thing as "washing the valves," with force feed lubrication, because every stroke is made with oil-impregnated steam. These lubricator pumps will deliver oil against 5,000 lbs pressure. No sag in the oil pipes, however great, interferes with the regular delivery of oil. There is no case of injecting a lot of oil the instant the steam is shut off.

After testing out one of these lubricators a prominent railroad specified it on 12 new super-heated passenger engines with 25x28 in. cylinders and 75 in. driving wheels. These engines were put in service in September and October, 1917.

Engine No. 1619 on this road, which was the first one to require a change of packing rings, had made up to the 27th of August, when the packing rings were changed, over 94,000 miles, owing to the piston's striking the front cylinder head. These packing rings were worn a little less than 1/32 of an inch, and the engine had made an average of about 90 miles to the pint of valve oil.

Another engine No. 1618, which had made the next greatest number of miles, has since gone over 105,000 miles without requiring the packing rings to be changed. These engines are running without swabs or oil cups on either the valve stems or the piston rods or their extensions.

Another prominent road put in service in April last, 7 large 2-10-2 type locomotives equipped with force feed lubricators. These engines have 72,000 lbs. tractive effort and use super-heated steam. They have made approximately 23,000 miles without a change of cylinder packing rings, except in one instance, where one of the engines was lame.

Still another of our railroads having tested one of the force feed lubricators for about a year and a half, specified them on 10 large 2-10-2 type locomotives and 20 Mikados. All these engines were put in service in May of this year. Five of the 2-10-2 type were given to the Erie which they used for about two months with success, and 10 Mikados were given to a very well managed railroad. This left 5 2-10-2 type and 10 Mikados for use on the Rock Island.

Ten Mikados on another road have made over 21,000 miles without a change of cylinder packing rings. Most of the engines on the various railroads average about 6,000 miles to a set of cylinder rings, including passenger and freight. One railroad that does an extensive business, has recently put in service 65 engines equipped with force feed lubricators, that are doing well.

From these somewhat disjointed facts, which we have been able to gather, and which facts can be easily verified, it would seem that the force feed idea is good, as it is thoroughly automatic, and works only when it should, and with the requisite degree of intensity. There is no chance of oil-fed to a bearing not getting to it, and it is possible to set the lubricator so that the required quantity of oil will be used—no more, no less. That is an important point in these days when waste of material is considered to be a grave operating fault.

Peat.

In the United States peat had received but scant attention, except at the hands of a few widely scattered experimenters, until the winter of 1902-3, when the strike of the miners in Pennsylvania brought a large section of the country to a realizing sense of its almost complete dependence on that group of men for its supply of fuel. Since that time there has been a series of attempts to produce peat fuel on a commercial scale. The one that came nearest to success was that of the Boston Peat Company, at East Lexington, Mass., where an excellent quality of peat and an efficient machine was developed for forming the peat into bricks or briquettes. The enterprise met with some measure of success but was finally abandoned.

Regarding the peat deposits in the United States, it has been estimated that of the 139,855 square miles of swamp lands, about 8 per cent, or 11,188 square miles, will have peat deposits of good quality. Assuming that the average depth of the peat in this area is at least 9 feet, the average yield would be over 200 tons of salable fuel per acre for each foot of depth, the total available fuel in these deposits would reach about 13 billions of tons; and this quantity, if converted into machine-peat bricks and sold at $3 per ton, would have a value of about 40 billions of dollars, or sufficient to furnish the entire country with heat and power for many years.

Peat beds lie chiefly, as far as is known, north of a somewhat irregular line extending westward from close to the southern boundry of New York nearly to the ninetieth meridian, and thence northward to Canada. There is also a narrow strip extending southward to Florida and including the whole of that State, and reaches westward, probably across Texas to the Mexican border. There are also extensive areas in California, Oregon and Washington.

Generally speaking, peat is most abundant in regions remote from the coal fields, the only exception so far known being an overlapping of peat and coal in Michigan. It is noteworthy that in the southern States where other kinds of fuel are not readily available, the peat deposits are large, and it seems strange that a more careful examination into the possibilities of the peat resources of the country has not been made, as it can be produced with much less danger and less expense than coal, as it lies just below the surface of the ground. That the bulkiness of air-dried peat fuel would make the cost of transportation and of storage relatively high must also be noted.

In European countries where peat is used largely for domestic fuel, special stoves for it have been designed and sold, although they do not appear to have any very general use, as peat is usually burned in the same stoves or grates as other fuels, peat being an ideal fuel for an open grate. In the case of peat being used for steam power generation, larger and longer fireboxes are necessary than are used with coal. Almost all experiments in the use of peat in the generation of steam show that the same money spent for any other fuel will give a larger quantity of steam and that the other fuels will be given preference. In view of these facts it is not likely that any serious attempts will be made to introduce the use of peat as a fuel in the locomotive, but the more general use of peat fuel in common service may be confidently looked for, especially as the demand for a larger supply of coal will inevitably be made to meet the growing requirements of locomotive service.

It may be added that, as we have already stated, while the calorific value of peat and anthracite is about 7 to 12, peat is a better fuel than wood or the lignites with which it has been compared, and at its best is not much inferior to some grades of commercially important coals, although generally considered poorer. The best peat has about 75 per cent of the heating value of anthracite and about 80 per cent of that of the Illinois coals, or from 85 to nearly 90 per cent of that of the Rhode Island and Wyoming samples; the poorest of the peats with high ash and moisture content are only about half as valuable as the best of the coals and are commonly rated as 55 to 65 per cent as valuable as the poorest coals. These comparisons are made on a strictly commercial basis, the peat being air dried and the other fuels in the state in which they were received from the mines.

Tempering Steel Tools.

The hardness in tool steels of the carbon series depends on the percentage of carbon, and "mild" steel from which carbon is absent will not harden at all by purely heat treatment. Probably, in quenching, a small amount of carbon on the surface of the metal is lost where water is used, and on the same lines with oil quenching a little carbon is gained, but in neither case does this appreciably affect the hardness or toughness of the body of the metal. The principal reason of the difference arises through the different rates of absorption of the heat in the two fluids, the cooling being slower in oil than in water, and a heavy, viscid whale oil will give a tougher result than a thin sperm oil, as you can readily determine by practical experiment.

Electric Cast Iron.

War conditions have developed several important improvements in the steel industry in the United States. Among others it has been shown that there is a possibility of making pig iron and iron castings direct from steel scrap in an electric furnace—something never accomplished before. It has been claimed that such iron, cast in the form of castings, is far superior to the same castings made from ordinary pig iron, melted and cast. Tests of this new iron recently made at Columbia University demonstrate its high quality. Its tensile strength was shown to be 40,730 to 45,030 pounds per square inch, considerably higher than that of ordinary cast iron.

Fire Lighters.

Recent experiments on the subject of fire lighters recommend the use of five parts of resin and two parts of paraffin being melted together and poured over four parts of wood chips, shavings or sawdust. Four parts of coal dust are then added, the composition when well mixed being poured into moulds. The moulds are shaped so as to form several briquettes joined together at their bases but capable of easy separation.

Locomotives in China.

From reports furnished to the Department of State it appears that there is a growing demand for American locomotives and equipment in China. The locomotives furnished by European builders have proved too small, but as the roads were largely financed by European capital, the American builders have not had a fair opportunity.

Failure of Improper Lubrication

By W. J. SHLACKS, Locomotive Lubricator Company

I was very much interested in the article of "Causes of Improper Lubrication" in your December issue.

I was disappointed because of your statement that the admission of air or smoke box gases "cannot be prevented by automatic devices, for sooner or later they will fail." If you had said that about the block system or the air brake, or any of the present highly successful automatic devices, that are so necessary to the efficient conduct of transportation, and the prospective inventor had been discouraged, because he took your word for it, we wouldn't have them today. You should rather encourage inventors when a careful study of the conditions points to the improvement that would result from the use of such an automatic and reliable device.

I feel sure that such a device will be brought out and will be successful in the face of your statement. Your later statement, however, contradicts your former statement, for in that you well give the requirements of a good drifting valve. All of the causes that you give for improper lubrication of valves and cylinders do not include the frequent and regular delivery of oil into the steam. Too much oil is as bad as too little oil, but we must contend with this so long as we persist in delivering the oil in a measure of time, instead of in a measure of actual valve and piston travel.

If an engine is given the same amount of oil while running sixty miles per hour as when she is running eight miles per hour, it is conclusive that she is either getting too little at one time or too much at the other. If we persist in allowing the steam pipe pressure to affect the oil delivery, so that the highest steam pressure or steam velocity receives the least oil, when we should give the highest steam pressure or velocity the most oil, the results are going to be just what we should expect.

The higher the steam pressure the more steam there is in a certain volume and the more steam would be impregnated with the oil, so that each cubic inch of steam at the higher pressure must contain less oil (if the whole is given the same quantity) than each cubic inch of steam in the lower pressure.

I confidently feel that if each of the conditions that you cite as bad are eliminated when a force feed lubricator is used that will actually deliver the oil into the steam pipe at each revolution of the drivers in proportion to the cut-off, the railroads can expect one hundred and fifty thousand (150,000) miles to a set of cylinder packing rings on super-heated passenger engines with 25 ins. x 28 ins. cylinders and 75 ins. drivers, with records on all other power in proportion to the valve and cylinder area and the diameter of the driving wheels.

I am in a position now to show results that are approaching the mileage above mentioned with a force feed lubricator that is inefficient compared with the results that can be confidently expected from the use of a very much more efficient machine of later design. When you realize that some of our best railroads are averaging six thousand (6,000) miles to a set of cylinder packing rings, whereas, I have seen records on the heaviest super-heated power of twenty-one thousand (21,000) miles and records over one hundred thousand (100,000) miles on passenger engines, and where one railroad has as low a record as eight hundred (800) miles and has as high as forty-two thousand (42,000) miles, a spread of more than fifty (50) to one (1), it all goes to prove the necessity of some reliable automatic oil delivering device.

One can readily discover by the conditions of the valve stems and piston rods if no oil or swab cups are used, whether or not the engine works steam always while running—that is, when a force feed lubricator is used, so that up to the time when we are all looking for, when an automatic and reliable drifting device is manufactured, you can have a close check on whether the engineer used steam or not while drifting.

We are pleased to give publicity to Mr. Shlacks' interesting article on the subject of lubrication. At the same time, we would remind our readers that at the outset of our article published on the subject in our issue of last December, that our statements were based on opinions advanced by several of the leading members of the Traveling Engineers' Association. The subject has been repeatedly discussed at their meetings as well as at meetings of other associations and clubs, and the general opinion among those who have the best opportunities of observing the action of devices used in preventing the admission of air and smokestack gases into the cylinders was that the devices have not been as reliable and enduring as might be wished. Nothing could be further from our mind than to discourage a fair trial of new devices. We are constantly looking for them. We rejoice in the marked improvements, especially in material, made in recent years, and cordially join with Mr. Shlacks in the hope that an automatic drifting device will soon be perfected that will thoroughly meet all the requirements of the situation.—Ed. R. & L. E.

The Preparation of Peat Fuel.

By Thomas Dunkin Paret, Sarasota, Fla.

I was much interested in your recent article on "Peat," which has been copied in *The Literary Digest* and other periodicals. It may interest you to learn that an apparently much better process for the reclamation of peat was experimented with near New York about a half a century ago. The experiment which I witnessed was made, I think, in the year 1866. It was at Montclair, in New Jersey. The process seemed to be perfectly practicable, but I do not exactly remember whether the peat, after excavation, was macerated in the same machine where the compression of the peat took place, or whether the compressor was a separate machine, which compressed, shaped and partly dried the peat at one operation.

The ground or macerated peat was conveyed to a hopper, from which it was fed into a cylinder, placed horizontally, and through which a piston with a reciprocal motion was forced alternately backward and forward. In this cylinder the peat was greatly compressed, and much of its moisture squeezed out. It was delivered in a strong stream from an opening in the machine, and cut in lengths, in cylindrical form, about 5 ins. in diameter.

Doubtless it is likely that a search of the patent records about that period would disclose some details of a patent record. The patent, of course, would be run out by this time. No doubt improvements could be made, and if water or other cheap power could be advantageously and economically used, it seems reasonable that peat could be produced in regular form and desirable sizes, with its bulk greatly reduced and much of its moisture removed, with one machine and one operation accomplishing the desired result.

The American Rivet.

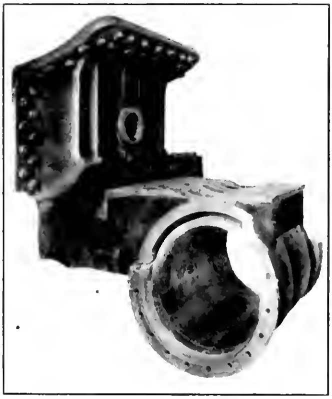
The American rivet is superior to any other. In the older types when they have to be removed it has its original head cut off, and it is then backed out by a punch and flogging hammer. The reason it is "backed out" is because at the end of the rivet where the "made" head is situated the metal has showed signs of flowing, and tightly filling the hole under the influence of the forming hammer. Caulking is not usually applied to the "made" head, and the metal below the permanent head has not shown any tendency to flow or tightly fill the hole. The "American" rivet with its hot pear-shaped head forces the stalk of the rivet immediately under it to flow, and so fully, completely, and tightly fill the hole. It is a decided improvement.

Sheedy Method of Preparing Slide Valve Cylinders for Piston Valves

There has recently come to our notice a method of converting the old-fashioned slide-valve cylinders of a locomotive to the more modern form for piston valves, with outside steam pipes. It was devised by Mr. Patrick Sheedy, Superintendent of Motive Power on the Southern Pacific Company at Los Angeles, California. The method is simple, it is mechanical, and it has been so worked out that it is comparatively inexpensive—much less so than scrapping previously used cylinders and chests, and using new. The change can be made without depriving a railway company of the use of the revenue-producing locomotive, for any considerable time, and it carries with it the possibility of effecting a further economy by the use of a superheater. When turned out, the engine gives no further trouble in this respect, and its useful work begins at once.

SHEEDY VALVE CHAMBER READY TO DROP INTO PLACE.

The adoption of this method gives railway officials a feeling of satisfaction because the whole scheme was brought to

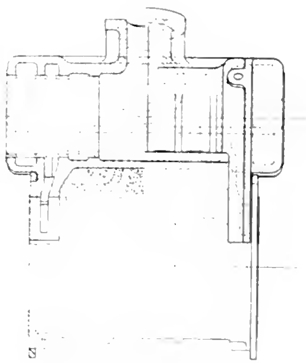


CYLINDER AND HALF SADDLE READY FOR SHEEDY VALVE CHEST.

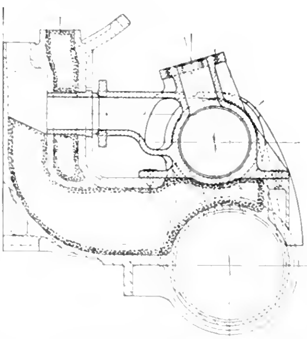
light by a practical man, engaged at the present time in active work, who successfully uses his own plan on his own road, and is prepared to share the good results with others, who have similar problems presented to them. The idea is practical, devised by a practical man with brains, standing, as it does, on its feet, it takes the hard knocks of operating conditions on a large and busy railroad where results are looked for, and take precedence of visionary ideas however well they may be supported by plausible theories.

Speaking of his own way of doing things, Mr. Sheedy himself says: "The principal difference in my plan, and that used by others, is that by the one I describe, the engine is converted or modernized so that when the job is done, it is the equivalent of a new engine in every respect, having piston valves and outside steam pipes, and as there are no steam joints to take care of, it becomes a permanent job which is completed at the time the changes are made, rather than having a bolted or separate piece with a piston valve, and otherwise corresponding to the old slide-valve steam chest. This method of conversion will appeal to the many readers of your journal, as having distinct advantages over detachable chests with wired joints and bolts to be depended upon for holding them in place and making them steam tight."

Among our engravings it will be noticed that one of them shows a half-cylinder and steam chest as in regular service. Another shows the cylinder with steam chest removed; and still another shows this identical cylinder and valve-seat machined to take the new piston valve chest. One may notice that a notch has been cut out of the cylinder at the front and back, to receive the steam chest which contains the direct steam ports in the leg of the casting which makes the front and back portion of the new cylinder. The valve-seat has been machined away with a boring bar to fit the outside of the steam chest. This is a solid casting having no ports or steam passages connecting with the former valve-seat. The illustration also reveals a cast iron bushing which is passed through the outer wall of the saddle and into the old exhaust port which has been filled up with a mixture of cement and cast iron borings below the connection point. This arrangement provides the opportunity for applying a piston-valve, of as large a diameter as may



VIEW SHOWING NOTCH CUT IN CYLINDER FRONT AND BACK.



SECTION VIEW SHOWING WROUGHT IRON BAND IN POSITION.

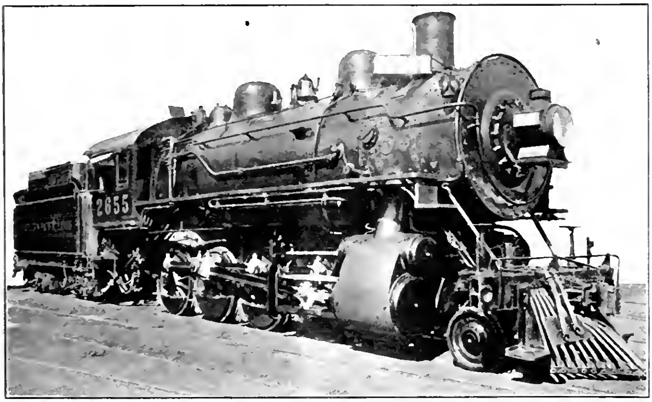
be desired. The advantage here is that ordinary fitting work may be done in placing the chest on the cylinder, and that the necessary and accurate jointing is secured by the use of an easily applied bushing. The bushing makes a steam tight job.

The valve chamber when in position has a wrought iron band shrunk round the projecting end of cylinder and valve chamber, which holds the two together. This is the principal fastening but in addition, a series of bolts between the ribs, is also used to further secure the steam chest in place.

Another view displays the wrought iron band in place and also the exhaust pipe arrangement and the lower portion of the outside steam pipe connection. An impor-

tant feature of this device is that it is not necessary to make an exact fit between the cylinder and valve chamber, only an ordinary bearing is necessary because the wrought iron band that holds the two together, and the one steam joint is where the cylinder wall has been cut away. The cylinder is then bored out and a bushing inserted which covers this joint, and there is, therefore, no steam joint of any kind or description to be maintained and the cylinder becomes to all intents and purposes the equivalent of the new style modern cylinder, cast integral with outside steam-pipe connection. There is here the entire elimination of steam leaks, and this is done without necessitating an absolutely accurate joint between the valve chest and the cylinder. There is also by the Sheedy method the capacity for substituting short direct ports for the old long ports, with corresponding advantage in the reduction of appearance in the finished job, the advantage of the direct steam ports between valve-chamber and cylinder with a lesser amount of radiating surface and a lesser liability of cracking of ports on account of the high temperatures of superheated steam. There is the further advantage that all parts of the valve-chamber and valve-motion are identical and interchangeable with other engines of similar class having piston valves.

It is thus seen that the whole plan is an excellent example of "means adapted to an end" in which Mr. Sheedy and the Southern Pacific may well feel every satisfaction. It is one more manifestation of many, which shows the growth of the scientific spirit applied to investigating conditions and thinking out expeditious ways of meeting them. To do this work in its best form, requires that the inventor has to bear in mind the adverse forces of various road conditions as they really are,



SOUTHERN PACIFIC LINES ENGINE WITH SHEEDY CYLINDER AND VALVE ATTACHMENT.

clearance. These several advantages, the elimination of leaks by the application of the bushing; the short straight ports; and the unnecessary trouble of accurate fitting of awkward parts, makes the whole thing worth while.

The engine we have selected for illustration with this article is one, with the converted cylinders, which has been in service several months, together with several other engines of similar style. The Southern Pacific Company are converting these engines as fast as possible and by this process. This railway is using the same bushings, valves and other parts that have been used on similar engines having piston valves. They find the engines in service quite the equivalent of engines built originally with such cylinders, as no further repairs or upkeep are necessary after the job has been completed. In addition to the very substantial arrangement, which has a pleasing and which tend to speedily eliminate pet ideas, and coddled devices. In this, and through this, and above all, there is the dollar-and-cent test, in which there can be no armistice and no negotiated peace. A good device in order to stand now-a-days must have inherent merit. It must win outright. This plan of conversion deserves consideration and investigation by those who have the matter of the conversion of engines on their hands. The work can be done quickly and it is comparatively cheap. When done, it stays done, and is able to go up against the "use 'em rough" conditions of arduous railway service, day in and day out, all the year round.

It is thus gratifying to observe that in these strenuous times when every effort seems to be exhausted in keeping the wheels turning some of our brightest minds find time to make needed improvements in some important details.

Women in Railroad Service.

It is probably too early to determine to just what extent women will be a permanent factor in the railroad service of the future, but just at the present time we are impressed with the important work they are doing in the general offices. It has been the pleasure of the association to open its membership for limited privileges to these young women employees, and they have been quick to show their appreciation by joining in considerable numbers. They are regular patrons of the cafeteria, restaurant, library and the various entertainments, and their presence at all of these features has introduced a new and pleasing element in association life. They have been dignified and modest in their demeanor, and have typified the spirit of the American woman in a manner that has been gratifying to all concerned. With the return from the war of a vast number of former railroad clerks, it will be interesting to watch the readjustment and discover how far it is deemed advisable to change the present order of things. In any event, it will probably be conceded that the American woman has done her bit in railroad endeavor as she has in many other lines of employment when the country needed her most.

Caustic Soda.

The safest method of handling caustic soda when received in iron drums is to punch two holes in the lid on an unopened drum, place the drum in a tank, cask or convenient receptacle. Send a steam pipe jet into one hole and open the valve. It is possible by this kink to make up 30 per cent solution speedily and safely. To dilute is a simple matter, and to duplicate a certain strength a hydrometer is the safest method. Alkali, like all forms of grease, is now expensive and difficult to procure, and it is believed that caustic can be substituted for milder alkali, such as soda ash, if the proper means of handling and using are established.

Railroad Embankment of Molten Slag.

The plants of the Carnegie Steel Company in the Monongahela Valley are disposing of their slag to build a railroad embankment along the river. The molten slag is hauled by ladle cars, which are provided with compressed air dumping mechanism which may be operated from the locomotive. The mechanism is locked to hold the ladles from spilling slag along the track. Bridges are floored so that there will be no damage from slag that may drip over. The fall of the embankment is faced with blocks of cold slag, and the space behind this wall is filled with molten material. It makes an excellent filling in low ground areas.

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Railroad Trade with South America

Now that the war is over and the period of reconstruction has been ushered in, the minds of many peoples are turned toward the matter of foreign trade. The United States must not only wish and hope that some of the good things will come to it, this country must make some good, strong intelligent and well-directed efforts in that direction, and especially in the field of railway supplies. Our friends of the railway supply fraternity must take this matter up in dead earnest, and those who do can count upon the hearty and able support of RAILWAY AND LOCOMOTIVE ENGINEERING, for we have many friends in South America.

In the matter of transportation, there is Bolivia. This country is land locked, having no coast line. There are three lines running toward the Pacific. The Antofagasta, which is owned by British shareholders, has the heaviest freight traffic. It runs 270 miles to the frontier of Bolivia, then 108 miles to Uyuni, and 195 miles to Oruro. Another road, built by the Bolivian Government, is 183 miles long, administered by the Antofagasta Railway. The distance from Antofagasta to La Paz is 711 miles. The shortest line from Arica to La Paz, built by the Chilian Government, is meter gauge and 264 miles long. There are about 800 miles of railway at present, with prospect of more. With the exception of the Antofagasta Railway and the Guaqui-La Pashne (a Peruvian Co.), all Bolivian railways are under a government guarantee.

The railways of the Argentine make about 21,196 miles in all, with further work going on. In these undertakings British capital predominates. The Argentine Government owns about 3,800 miles of road, and has been interested in opening up new territory. This country uses 5 ft. 6 ins. gauge; a 4 ft. 8½ ins. (standard), and another one meter wide (3.28 ft.). Some idea of the rapid growth of railway transportation may be had by remembering that in 1890, there was only 5,857 miles and by 1813 it had risen to 21,196 miles.

In Brazil in 1912 there were 13,840 miles of railway in operation, of which 471 miles had been built as late as 1911—the year previous. Nearly all the railways are owned by governments, either federal or state. Railway enterprise is far from being at a standstill, as 2,386 miles were under construction and 3,152 miles had been authorized. Extensive construction in the coffee district consists of 3,482 miles, built in 1912. The Central Railway of Brazil is the trunk line of the country, and is 1,236 miles in length.

The railway construction in Chile at the beginning of 1912 had progressed so far that 3,948 miles were in operation, about half of which were owned by the government, the other half being built by private funds. The Antofagasta & Bolivia Railway (274 miles) is one of the principal routes of travel The Arica-La Paz Railway is another. The Chilian section of this line is about 129 miles long. The Central Railway, a road from Valparaiso to Puerto Montt with branches, is 700 miles long. The northern section of the Longitudinal Railway, from Pueblo Hundido to Pintados, is about 441 miles long. The gauges vary from 2 ft. to 5 ft. 5 ins. Several of the government roads show an annual deficit.

In the republic of Colombia, railway building has been slow. The principal lines are: the Santa Marta Railway, 3 ft. gauge and 84 miles long; the Barranquilla Railway & Pier Co., 3 ft. gauge and 18 miles long; the Cartagena Railway, 3 ft. gauge and 65 miles long; the Great Northern Central of Colombia, now being built with meter gauge (3.28 ft.) and 95 miles long, opens up a rich country. This line, it is expected, will eventually be built to Bogota. The Antioquia Railroad, not yet finished, will have a 3 ft. gauge and be 125 miles long. German capital has been interested in this line, but recent events may make the transfer of predominance of United States money easy. The Cucuta Railway connects with Villamizar and leads to an outlet to the sea. Another road across the frontier, 18 miles long, connects Cucuta with Tachira.

Equador has 310 miles of railway line in operation, the most important being the Guayaquil Railway, and the Quito Railway, about 285 miles long. There seems to be a field for extension here if an attractive proposition were placed before the authorities.

Paraguay appears somewhat backward in the matter of railways. Transportation is carried on very largely by mules. One railway, which runs from Asuncion to Villa Encarnation, forms a pleasing exception. A projected railway is the Trans-Paraguayan Railway, passing east to the frontier of Brazil, is to connect at that point with a line to Sao Francisco on the Atlantic coast. The Farquhr company controls the Paraguay Central and is interested in the Trans-Paraguayan line and intends to construct a road from Asuncion with the Argentine line.

Peru, although not overburdened with railway lines, yet had in 1913 at least 1,840 miles. This railway is controlled by the Peruvian Corporation. The principal railways of Peru are: the Central Railway, 249 miles long; the Southern Railway, 537 miles long; the Northwestern Railway, 123 miles long; the Pacasmayo & Guadeloupe Railway, 98 miles long; the Paita-Piura Railway, 65 miles long; the Pisco-Ita Railway, 46 miles long; the Trujillo Railway, 72 miles long; the Chimbote Railway, 65 miles long; and the Ilo-Moquega Railway. 162 miles long.

Uruguay, early in 1913, had 1,570 miles of railway, all 4 ft. 8½ ins. gauge, nearly all built by British money. The level character of the country makes railroad building comparatively easy. There are five systems of railway, comprising the Central Uruguay Railway, the Midland Uruguay Railway, the Northwestern of Uruguay, the Uruguay Northern, and the Uruguay East Coast Railway. The Uruguay Company is organized under the laws of Maine, U. S. A., and a contract has been signed to build a line from Montevideo to the junction of the Midland and the Central Uruguay lines, 205 miles. Another, not very long, to connect with the East Coast Railway at Olmos; and another, 50 miles long, from San Carlos to Rocha.

Railway construction in Venezuela has not been rapid. The lines are nearly all short. The total mileage in 1912 was only 528 miles. The railways are the La Guira & Caracas, 22 miles long; the Great Railway of Venezuela, 111 miles long; the Central Railway of Venezuela, 34 miles long; the Puerto Cabello & Valencia, 34 miles long; the Bolivar Railway, 109 miles long; the Caranero Railway, 33 miles long; the La Vela & Coro Railway, 8 miles long; the Guanta Railway, 25 miles long; the La Ceiba Railway, 50 miles long; the Tachira Railway,

71 miles long; and the Santa Barbara & El Vigia Railway, 23 miles long. These roads give a total railway mileage of 520 miles.

It is evident from this brief survey of railway work in South America, many of the facts have been gleaned from a compilation of the National Foreign Trade Council, that the South American republics need their ideas stimulated and enlarged as to the use of railways, for the purpose not only of facilitating commerce, but of producing yet more. Construction companies have the first entrance to the field, and after them naturally come the locomotive and car builders and the swarm of concerns which sell engine and car accessories. All these have their legitimate place, and if concerted action were taken, and the whole problem studied intelligently and means used, it could not fail to produce beneficial results. Our trade with South America has been slow and feeble so far. Concerted and unified action, like an army at war, under competent guidance and full knowledge of conditions, must lead far toward success. South America lies at our very door, more easy of access to us than anyone else. We must go in to give the best goods, endeavor to please, and our reputation will be the highest.

The Ideal Shop Foreman.

The important advance made in the present century in the training of apprentices cannot be overestimated. This is especially the case in the mechanical department of railways, but it should not end there. The training of foremen is equally important, and in some respects more so, and yet this is frequently left to personal selection, not always based on fitness. Shop foremen often serve an apprenticeship after they are on the job, and do not always develop the necessary qualifications.

The ideal foreman has business abilities and an irreproachable character, a first-class technical education, and a high degree of skill as a craftsman. There are, however, few ideal foremen, and very many employers ignore the point of character, and either show a preference for a skilled man with small business ability, or a good business man and organizer who is an indifferent craftsman. There is no reason why the average foreman should not approach the ideal, and it is regrettable that our technical institutions have no courses of training suitable for ambitious young mechanics who aspire to become foremen. It is usually the best class of lads and young men who attend technical classes, and although the diploma which they may receive is a guarantee of years of application and a knowledge of principles which is invaluable, the man may be still unsuitable for a foremanship. It would appear to be desirable either to have a course for a supplementary diploma on "Foremanship," or to include lectures on organizing, and the best way of dealing with men in the ordinary diploma course. Whatever department of life we consider, it is not always the most brilliant scholars who are the best leaders, or who make an enduring mark, but those men who have the inherent or acquired qualities which enable them to restrain wisely, and, when commanding, to win respect. It is a very great advantage for the foreman to be able to express himself, and to explain in a lucid way what he wants, and the best way of doing it. To convey one's ideas to others is largely a matter of education, as clearness of expression is not altogether a gift. It may be contended that the difficulty of procuring good lecturers would be great, but there are men in every large technical school eminently qualified to give instruction in organization. It would be a wise procedure for large firms to run courses of lectures for their foremen during the winter months, and such lectures could be delivered by outside scholars and by managers who have had a wide experience.

"Iron Sharpeneth Iron."

The early history of the locomotive forms an interesting study, and as the story progresses we see the inevitable working of that most potent law—Evolution. Nowhere but in the fabled mythology of Greece did the supreme power make anything in its permanent form, and then even the unrefuted record by that nation gives but one single instance. "Minerva sprang fully accoutered from the brow of Jove." All through the history of things mundane, each separate achievement has become only the stepping stone to further advance. Iron sharpeneth iron; so a man sharpeneth the countenance of his friend. He imparts his ideas and tells of his progress, and the face of his friend glows with intelligent appreciation.

When the days of locomotive construction, on primative lines are recalled, we find at first the endeavor to carry fuel and water, and to make the structure strong enough, the necessary formation of rails, the toothed rack, and finally the experiments to get at the fact that a smooth rail would permit sufficient adhesion to allow a propelled wheel to move forward over its surface. In early days the work of the various experimenters and builders actually resolved itself into a sort of competition to build engines which would work, nothing more. As time went on and as the steady and plodding work of experimenters and enthusiasts progressed, the endeavor they made grew away from the clear-cut desire to produce only workable engines, and became a striving for better engines of the class then known, by improvements being incorporated.

Further action along this line, as soon as the good engine had been produced, tended to the production of the larger engine, built very much as the small, good engine had been built, but here and there showing examples of slight and beneficial differences, almost forecastes of the later stage. The creation of the engine led to the evolution of the small, good engine, and this machine was, as it were, but the stepping stone to the large engine, with the inevitable competition in the building of the large engine. When this had approached a maximum, by continually improving details anl parts, competition again veered to the building of the large, good engine. In all this, the small engine, the small good engine, the large engine, and the large good engine, we have a concrete example of the working of the law of evolution, and this law as certainly guides progress in the things made by man's hands, as it unfailingly operates in the realm of organic advance and as it does in the development of nature.

All through this formative period there had been evidences of slight moving away from the main and more definite process, and these various movements have évidenced themselves in the discovery and adaptation of special appliances for doing certain things—the injector is perhaps one of them—and these specialties have been the efforts of those who have become identified with this particular branch of work. The very evolutionary process of which we have been speaking has had, as one of its results, the creation of the specialist as such. The process is analagous to that by which, in astronomy, a primary is believed to have thrown off what eventually has become its satellite.

The form which this locomotive evolution has followed has at length developed into a system of locomotive building and equipment which causes the engine to be "made to fit." A railway mechanical engineer (in theory at least) studies his home road conditions and requirements very thoroughly, and is so able to lay them before the locomotive builder, exactly as they are, and as new power should be built. He may express his preferences, but when all is said and done, it is the locomotive builder who essays the task of producing the best engine for the conditions set down, and in fulfilling the requirements, the builder has at his disposal all the accumulated experience and the finished product of the maker of accessories. He is not called on to make the best form of any outside appliance; it is already available and exists as the product of those who have devoted their energies to its production, in most excellent quality.

Air Brake Department

Differences Between PM Brake Equipment. High Speed Brake With Type L Triple Valve and LN Equipment—Supplementary Reservoirs Should Be Used in Connection With Type L Triple Valves

(*Continued from page 388, December, 1918*)

There is no question that the quick recharge feature is anything but a failure where the type L triple valve is used without the supplementary reservoir, for as soon as the brake pipe pressure is four pounds or more in excess of the pressure in the auxiliary reservoir the additional charging port is opened and the L triple valve starts to absorb brake pipe pressure at about 30 cu. ft. of free air per minute, overcharging the reservoirs at the head end of the train and charging faster than PM equipment in any portion of the train and during repeated application unequal auxiliary reservoir pressures are obtained, resulting in unequal retarding effect on various cars originating from unequal brake cylinder pressures, with a net result of velocity differences, rough handling and slid flat wheels as mentioned in connection with the quick service feature.

Graduated Release.—This feature of retaining a certain amount of brake cylinder pressure during release, or releasing a portion of the air pressure from the brake cylinder is accomplished by having the supplementary reservoir connected with the auxiliary only when the triple valve is in release or emergency position. When in service application position, the supplementary reservoir pressure is "bottled up" or not used, and while the auxiliary reservoir pressure expands into the brake cylinder, the supplementary remains at its original pressure, and when connected with the auxiliary reservoir when the triple valve moves to release position, it charges at the same rate as the brake pipe from the locomotive, and if the increase in brake pipe pressure is not maintained at the original adjustment, the inflow from the supplementary reservoir will force the triple valve to graduated release lap position, closing the communication from the brake cylinder to the atmosphere, thus by alternating the brake valve handle from first to release, then running position, back to lap, and thereafter between running or holding and lap, the pressure may be graduated out of the car brake cylinders in a similar manner that the pressure is graduated out of the locomotive brake cylinders with the ET locomotive brake equipment. Considering that the brake cylinder pressure on all cars may be reduced as the train is approaching the point of desired stop, the possibilities from a viewpoint of smooth operation during a stop with a passenger train are almost unlimited. In any event this feature will require no elaboration to point out its advantages to anyone with an understanding of brake operation.

Safety Valve Feature.—This valve maintaining brake cylinder pressure between the limits of 58 and 62 pounds during service operation, limits the service braking ratio of the car. From an engineering point of view this predetermined ratio should be obtained from a 24-pound drop in the pressure in the auxiliary reservoir and should produce a nominal brake shoe pressure equal to 90 per cent of the light weight of the car, and for a strictly pneumatic brake should be obtained in 7 seconds time. It is also generally agreed that the emergency braking ratio should not be less than 150 per cent, hence the safety valve is cut off from communication with the brake cylinder when the triple valve has assumed quick action position during an emergency application of the brake.

High Emergency Brake Cylinder Pressure.—The high emergency brake cylinder pressure is obtained by the triple valve adding the supplementary reservoir volume to that of the auxiliary reservoir, the latter being opened directly with the brake cylinder when the triple valve is in emergency position. Through the combination of the two volumes an original brake pipe and reservoir pressure of 110 pounds develops approximately 105 pounds pressure in the brake cylinder, and the safety valve being cut off, this high brake cylinder pressure is maintained to the point of stop. This produces an emergency braking ratio of approximately 100 per cent of the light weight of the car where the service braking ratio is 90 per cent based on a 24-pound drop in pressure in the auxiliary reservoir. Briefly stated these are the principal advantages of the LN equipment over the PM, it being understood that the type P triple valve must move to release position before the auxiliary reservoir can be recharged for subsequent brake applications, and when in release position no brake cylinder pressure can be retained without a re-application or the use of retaining valves; in this way the brake is anything but flexible or easily bent to the will of the operator, but on the other hand is what is termed rigid or hard to handle, as after an application of the brake the auxiliary reservoirs must be recharged, as uniformly as possible, from the main reservoir of the locomotive before the brakes are ready for another application.

LN equipment can be successfully handled in any ordinary passenger service, or cars can be indiscriminately mixed with any other type of equipment regardless as to opinions to the contrary, as this is being done every day. On one particular road every car equipped with supplementary reservoirs has them cut in regardless as to position of the car in the train or as to the number of cars in the train equipped with or without LN equipment, or regardless as to the train the car is made up in, and moreover the LN equipment mixed in any manner whatever is being handled by obsolete types of locomotives with 9½-inch air compressors and main reservoirs or from 20,000 to 25,000 cu. ins. storage capacity.

In three different air brake tests it has been conclusively proved that modern heavy passenger cars cannot be stopped from 60 mile per hour speeds in less than from 1,800 to 2,200 ft. distance on a level track, and with LN equipment applied to these trains without any change in foundation brake gear, the stop distance from 60 mile per hour speeds was reduced to 1,300 to 1,400 ft. Obviously every car in a train equipped with the LN brake assists in reducing the possible stopping distance and the train stop distance will naturally be reduced in proportion to the number of cars of LN equipment in the train, and inasmuch as it is a fact that they can be successfully handled when mixed in trains in any conceivable manner, there is nothing much more than the legal side involved, that is, if cars with supplementary reservoirs are operated with the supplementary reservoirs cut out, the efficiency of the emergency brake, if not the service also, is impaired, and when the matter is brought down to the final analysis, operating cars with L triple valves and supplementary reservoirs cut out, may be construed as carelessness in neglecting to take advantage of the full value of the brake equipment from a viewpoint of safety, that is, in many instances where accidents have occurred there would have been no accident whatever had it been possible to stop the train in a few hundred feet less distance.

This is merely an effort to point out the principal operating differences between the

brake equipments, without any recommendations, because from an engineering point of view neither one of the brake equipments is worth the installation, or in other words, the triple valve as a car brake operating device has outlived its usefulness in modern passenger service or the demands upon it have exceeded its capacity in more ways than one, and as an example, any car brake operating valve that will apply upon the same differential in pressure that will be required to release it is "no good" for the obvious reason that the brake pipe pressure can be withdrawn at a more rapid rate than at which it can be restored, hence the tendency is for the brake to remain applied at many times when a release is desired.

Some objections have been offered because the LN equipment develops an emergency braking ratio of approximately 160 per cent, but such objections are based on a principle of "straining at a gnat and swallowing a camel," because practically all railroads haul cars equipped with the PC brake and offer no protest, and it develops 180 per cent emergency braking ratio and retains all of the cylinder pressure to the point of stop.

QUESTIONS AND ANSWERS.

Locomotive Air Brake Inspection.

(Continued from page 389, Dec., 1918.)

607. Q.—What is the recommended speed for the 9½, 11 and 8½ ins. compressors?

A.—140 single strokes or 70 cycles per minute.

608. Q.—For the 5A and 6A compressors?

A.—They should be run with throttle well open after 50 lbs. pressure has been obtained in the main reservoir.

609. Q.—What is the size of steam and exhaust pipes for the 9½ ins. pump?

A.—1-in. steam and 1¼-in. exhaust.

610. Q.—For the 11 ins. pump?

A.—1¼ ins. steam pipe and 1½ ins. exhaust.

611. Q.—For the 8½ ins. compressor?

A.—1¼ ins. steam and 1½ ins. exhaust.

612. Q.—What is the size of the main steam line when two 9½ ins. pumps are used?

A.—1¼ ins.

613. Q.—When two 11 ins. or two 8½ ins. compressors are used?

A.—1½ ins. main steam line.

614. Q.—What are the sizes of steam and exhaust pipes for the New York number 5 compressor?

A.—1¼ ins. steam and 1½ ins. exhaust

615. Q.—For the number 6?

A.—1 in. steam and 1¼ ins. exhaust.

616. Q.—What is the size of the main steam line if two of these compressors are used per locomotive?

A.—1¼ ins. for two No. 6, and 1½ ins. for two No. 5 compressors.

617. Q.—What change in construction caused these Nos. 5 and 6 compressors to be designated as 5A and 6A?

A.—The use of piston valves and packing rings instead of reversing slide valves.

618. Q.—What further change caused them to be designated as 5B and 6B?

A.—The elimination of receiving valves in the high pressure air cylinder when it was found that the separate valves could be dispensed with.

619. Q.—What is the difference between the 5 and 6 compressors?

A.—The principal difference is in the size of the cylinders and the stroke of the pistons.

620. Q.—Wht is the diameter of the steam cylinders of the 6A.?

A.—7 ins., with a 10-in. piston stroke.

621. Q.—What is the diameter of the air cylinders?

A.—High pressure 7 ins., low pressure 11 ins.

622. Q.—What is the size of the steam cylinders of the 5A?

A.—8 ins. in diameter with a 12-in. piston stroke.

623. Q.—What is the inside diameter of the air cylinders?

A.—High pressure 8 ins., low pressure 12 ins.

624. Q.—What is the size of the steam cylinders of the 8½ ins. compressor?

A.—High pressure 8½ ins., low pressure 14½ ins.

625. Q.—What is the diameter of the air cylinders?

A.—High pressure 9 ins., low pressure 14½ ins.

626. Q.—What is the diameter of the steam cylinders of the 10½ ins. compressor?

A.—High pressure, 10½ ins., low pressure 16¾ ins.

627. Q.—The diameter of the air cylinders?

A.—Same as the 8½ ins. compressor.

628. Q.—What is the length of the piston stroke of these compressors?

A.—12 ins.

629. Q.—What is the object in building a 10½ ins. compressor with no increase in the size of the air cylinders?

A.—To compress air to a higher pressure per square inch than the steam pressure on the boiler.

630. Q.—What is its performance in this respect?

A.—It will compress air to 130 lbs. with 100 lbs. steam pressure.

631. Q.—Are many of these compressors found on locomotives?

A.—There are some, but the 8½ ins. compressor is generally used with the modern locomotive boiler pressures.

632. Q.—What is the effect of running a compressor continuously against a high air pressure?

A.—It overheats it.

633. Q.—With what result?

A.—A reduction in the efficiency of the compressor.

634. Q.—In what way is its efficiency reduced?

A.—The compressor is then operating against what may be termed an unreal pressure or one that is obtained partially through an expansion incident to the high temperature of the compressed air.

635. Q.—How does this affect the quantity of free air that is drawn into the cylinder?

A.—The small amount that enters is almost instantly expanded to fill the cylinder, thus reducing the amount of free air that might ordinarily enter the cylinder.

636. Q.—How can this be demonstrated?

A.—By making an efficiency test of a compressor when in an overheated condition, and repeating the test after it has been cooled down.

637. Q.—Is it necessary to make a test to determine the inefficiency of an overheated compressor?

A.—No. Holding the hand over the strainer will indicate the difference in what is sometimes termed "suction."

(To be continued.)

Train Handling.

(Continued from page 390, Dec., 1918.)

633. Q.—Through what parts of the equipment does air pass from the main reservoir to the brake valve?

A.—Through the reservoir cut-out cock and usually a dirt collector and through the double-heading cock also if located in the reservoir pipe.

634. Q.—From the reducing valve, where does compressed air flow?

A.—To the independent brake valve nd train signal system if used.

635. Q.—From the automatic brake valve?

A.—Into the brake pipe.

636. Q.—What takes the place of the auxiliary reservoir and triple valves and high speed reducing valves when an engine is equipped with the E T brake?

A.—The distributing valve and reservoir.

637. Q.—What are the duties of the distributing valve?

A.—To control a flow of air from the main reservoir to the brake cylinders for applying the brakes, to maintain the brake cylinder pressure against leakage and to control the flow from the brake cylinders to the atmosphere for a release of brakes.

638. Q.—What pipes are connected to the distributing valve reservoir?

A.—The main reservoir supply pipe, the brake pipe branch, the brake cylinder pipe and the application cylinder and release pipe.

639. Q.—What pipes are connected to the automatic brake valve bracket?

A.—The reservoir pipe, the brake pipe,

the equalizing reservoir and the gauge pipe, a branch to the application cylinder pipe, a release pipe connection to the independnt brake valve bracket, and with some installations a pipe to the pump governor, a feed valve pipe if the brake valve and feed valve are separated and an exhaust pipe if the double heading cock is located in the reservoir pipe.

640. Q.—What pipes are connected with the independent brake valve bracket?

A.—The reducing valve pipe, the application cylinder pipe, and relase pipe branches to both the distributing valve reservoir and the automatic brake valve pipe bracket.

641. Q.—What pipes are connected with a double heading cock in the reservoir pipe?

A.—The reservoir pipe, the brake valve exhaust pipe and the reservoir gauge pipe.

642. Q.—What is main reservoir pressure used for?

A.—To release brakes and recharge the system after a brake application, to operate the pressure controllers and to furnish a supply of air for the operation of the tender and driver brake cylinders.

643. Q.—What is brake pipe pressure used for?

A.—To operate the distributing valve and the car brake operating valves throughout the train.

644. Q.—What is the equalizing reservoir pressure used for?

A.—To operate the equalizing discharge valve of the brake valve.

645. Q.—What part of the distributing valve operates when the independnt brake is used?

A.—The application portion.

646. Q.—What part when the automatic brake valve is used to apply the brakes?

A.—Both the equalizing and application portions.

647. Q.—How many positions has the independent brake valve?

A.—Five.

648. Q.—What is release position of the independent valve used for?

A.—For releasing the engine and tender brake whenever it is desired to release them independently of train brakes.

649. Q.—What is running position used for?

A.—This is the normal position of the valve when brakes are released, and it establishes a communication between the exhaust part of the equalizing slide valve of the distributing valve and the automatic brake valve.

650. Q.—What is lap position used for?

A.—To hold any pressure desired in the brake cylinders.

651. Q.—What is slow application position used for?

A.—For ordinary brake application while moving the engine and for use when inspecting or working about the engine.

652. Q.—What is quick application position used for?

A.—To make a stop quickly in case it becomes necessary.

653. Q.—What are the positions of the automatic brake valve?

A.—Release, running, holding, lap, service and emergency.

654. Q.—What is release position used for?

A.—Releasing brakes and recharging the brake system on a train of cars, and for holding the brakes on the engine and tender applied.

655. Q.—What is running position used for?

A.—This is the normal position of the valve to be used when running the engine either with or without cars attached, and is the only position in which the brakes on engine and tender can be released with the automatic brake valve.

656. Q.—What is holding position used for?

A.—For holding the brakes on the engine and tender applied while the train brakes are releasing.

657. Q.—What is the difference between holding the brakes on the engine and tender applied, while the train brakes are releasing, with the brake valve handle in release position and with the brake valve handle in holding position?

A.—In release position main reservoir pressure flows directly into the brake pipe while in holding position the brake pipe pressure is controlled by the brake pipe feed valve.

(To be continued)

Car Brake Inspection.

(Continued from page 391, Dec., 1918.)

570. Q.—How many sizes of freight car equipments are there in general use?

A.—Two.

571. Q.—What are they?

A.—8 and 10 in.

572. Q.—What style of triple valve is used with the 8 in. equipment?

A.—H-1 or K-1.

573. Q.—And with the 10 in.?

A.—H-2 or K-2.

574. Q.—What is the difference between H-1 and H-2 valves?

A.—Principally in the size of the parts, the number of bolt holes in the flange and the manner in which the check valve cases are fastened.

575. Q.—What parts are changed in size?

A.—The feed grove which controls the rate of flow to the auxiliary reservoir and the service ports which admit auxiliary reservoir pressure to the brake cylinder when the brake applies.

576. Q.—Does this enlarge the slide valve and bushing of the valves used with 10 in. cylinders?

A.—Yes.

577. Q.—Is the triple valve piston enlarged?

A.—No.

578. Q.—What is the cubic inch capacity of the auxiliary reservoir used with the 8 in. freight car equipment?

A.—About 1620 cubic inches.

579. Q.—Of the reservoir of the 10 in.?

A.—About 2800 in former types, but about 2450 cubic inches in later types.

580. Q.—What is the size of the brake pipe used on a freight car?

A.—1¼ in.

581. Q.—The size of the retaining valve pipe?

A.—⅜ in.

582. Q.—How long a time is required to charge an auxiliary reservoir from 0 to 70 lbs., if 70 lbs. pressure is maintained in the brake pipe?

A.—From 1½ to 2 minutes.

583. Q.—Is the charging time for both the H-1 and H-2 valves the same?

A.—The intent of the two sizes is that each will charge its reservoir in the same length of time as the other.

584. Q.—How is the brake pipe volume on a freight car found?

A.—By multiplying the inside diameter of the pipe by itself, and the product by decimal .7854 which will give the area. This multiplied by the length of the pipe in inches will give the contents in cubic inches. Doing this for the branch pipe also and allowing about 50 cubic inches for brake pipe space in the triple valve, will give the brake pipe volume.

585. Q.—How can the capacity of odd spaces be found without resorting to higher mathematics?

A.—By weighing the part, then filling with water and weighing again, and subtracting to find the weight of the water.

586. Q.—Under ordinary temperature, what is the weight of a gallon of water?

A.—About 8⅓ lbs.

587. Q.—How many cubic inches does it contain?

A.—About 231.

588. Q.—What space does one pound of water then occupy?

A.—231 ÷ 8.33 or 27½ cubic inches.

589. Q.—What is the capacity of the brake pipe space on the average freight car?

A.—About 700 cubic inches.

590. Q.—About how many cubic feet of space would there be in the brake pipe of 100 of such cars?

A.—700 x 100 or 70,000 cubic inches divided by 1728 or 46 cubic feet.

591. Q.—What is the 1728?

A.—The number of cubic inches in one cubic foot or 12 x 12 x 12 ins.

592. Q.—How much auxiliary reservoir space would there be in 100 of such cars one half 8 in. and the other half 10 in. equipments?

A.—1620 x 50 and 2800 x 50 would be 220,000 cubic inches or 127 cubic feet, or about 170 cubic feet of air space in the brake pipe and auxiliary reservoirs combined on the 100 car train.

593. Q.—Assuming that the brake pipe and auxiliary reservoir pressure is 70 lbs., how many cubic feet of free air would be contained in the brake pipe and auxiliary reservoirs?

A.—At 70 lbs. gauge pressure there will be 5.7 atmospheres.

594. Q.—How is this determined?

A.—Assuming 14.7 lbs. as one atmosphere, 70 lbs. gauge pressure plus 14.7 lbs. equals 84.7 divided by 14.7 or 5.7 atmospheres.

595. Q.—How can a convenient table be arranged to show this?

A.—As follows.

Gauge pressure	Atmospheres
40 lbs.	3.72 Atmospheres
45 "	4.06 "
50 "	4.4 "
55 "	4.74 "
60 "	5.08 "
65 "	5.42 "
70 "	5.7 "
75 "	6.1 "
80 "	6.4 "
85 "	6.7 "
90 "	7.1 "
95 "	7.4 "
100 "	7.8 "
110 "	8.4 "
120 "	9.1 "
130 "	9.8 "
140 "	10.5 "

596. Q.—What amount of these 5.7 atmospheres must be furnished from the air compressor in charging the train to 70 lbs?

A.—4.7

597. Q.—Why?

A.—Because the brake pipe and reservoir space contains one atmosphere before the compressor is started.

598. Q.—How much work would this be for an 11 in. air compressor making air at the rate of 45 cubic feet of free air if there is no leakage considered?

A.—170 cubic feet of space X by 4.7 is about 800 cubic feet of free air and this divided by 45 will show about 18 minutes' work.

599. Q.—There is however, brake pipe leakage present in all trains, and assuming a total leakage of 2 lbs. per minute from the entire volume, how many cubic feet of free air would be lost per minute through leakage?

A.—Two lbs. is about 1/7th of an atmosphere and 170 cubic feet of space divided by 1/7th equals about 24 cubic feet that would be lost per minute.

600. Q.—Sometimes this leakage is estimated from the brake pipe alone and sometimes runs to 10 and 12 lbs. per minute, assuming a leakage of about 7 lbs. per minute what number of cubic feet of free air would be lost per minute?

A.—One half of an atmosphere from the 46 cubic feet in the brake pipe or 23 cubic feet.

(To be continued)

Honoring Locomotive Enginemen.

We have, before now, had occasion to refer to the practice which has been adopted by several of our leading roads, and which consists in painting on the machine the name of the engineman who runs the iron horse so decorated. The name of the man, painted on the engine, (usually below the cab window) is intended to indicate that the man has become conspicuous, above his fellows, for the saving of coal, or oil, or in some way making a record of economical performance with the engine. The object is not only to recognize, officially, the good work done, but to serve as an inspiration for others.

The Canadian Pacific Railway has not only put this excellent record before other employees, but has created an artistic and decorative design which is almost heraldic in essence. It consists of a circular band of dark blue, with a marginal stripe of gold, below the cab windows, and on this deep blue, the name of the railway

DESIGN OF CIRCULAR BAND ON LOCOMOTIVES OF C. P. RY.

occupies the upper half of the circle and the full name of the successful engineman is in the lower half; all the lettering being in gold leaf, which standing on the blue band, makes plain reading, and is in good taste. Inside the blue band is crimson red, and upon this stands a white or silver shield. The "charge" on the shield is a dark green maple leaf, (Canada's emblem) and this is veined in light green color. A dark brown beaver surmounts the shield, as a crest does in armorial bearings.

The whole design is artistic, and has a national flavor which unobtrusively puts into the mind of the beholder, the significant name of the road, and the objects which the proprietors, and the Canadian Government had in view when this great national undertaking was in its infancy, and when it was finally incorporated as a private concern in 1881, with a state-aided mission to assist in the colonization of the prairies of the Northland, and to unite the distant provinces of the Dominion into one united and prosperous nation.

Case-Hardening.

In case-hardening the articles are finished as to size and form, except for a light grinding where extreme accuracy is necessary, and are then packed in flasks in the carbon producing material, which is usually some form of animal charcoal plus prussiate of potash, salt, or other chemical, which is presumed to assist in the absorption of the carbon. The flasks have covers thoroughly closed to prevent the admission of air, and are gradually heated to from 1,400 to 1,500 degs. Fahr., and held at that temperature for some hours. The exact temperature depends on the content and bulk of the metal, and is not constant for all things alike, but usually the variations are not great. When finished, the hardened pieces are dumped into cold water, and after being dried are finished off for use if the hardened casing is thick enough, or it may be necessary to again pack and heat them to increase the depth of the hard casing. As to the depth to which the metal is hardened, wear has to be considered, but as from a sixteenth to three thirty-seconds of an inch is as a rule ample, there is no advantage in deeper hardening, while in many cases less than the sixteenth of an inch gives all the wear required.

For thin work, heating to a full red and plunging in a hot solution of cyanide of potassium will give good results, more particularly if the heating and dipping is several times repeated; but this method of hardening usually causes the development of hair cracks, which rather spoil its effectiveness, and to some extent provide a means for rapid wear under some conditions of use. The hotter the solution is used the fewer and finer the cracks with steel, while with fibrous iron they become practically absent, but all wet treatments are rather apt to affect the surface of the metal, and this in the hands of the most skilful operator.

In the case of surface hardened non-ferrous metals, the effect is somewhat the same as in the case-hardened iron or steel, while in some instances there is some tendency towards peeling if the metal is bent about much, but the process has advantages for some kinds of work. The metal to be treated is freed from oxide as far as possible, fluxed, and sufficiently heated from underneath, the hardening metal being melted on the upper surface and well rubbed in until it alloys with the metal to be hardened. Surplus metal is then wiped off and the treated object allowed to become cold, when it is finished in the most convenient way.

In British practice, what is known as lute is used in closing the lid of the case-hardening box or flask. It consists of ammoniacal cobaltic salts of a yellow color and in chemistry is known as luteo-cobaltic chloride.

Electrical Department

The Electric Coasting Clock

During the last four years we have all been confronted with the great advancement in cost of materials and labor. In a great many lines of business the increased costs are offset by payments increased and it all comes back to the point that "the consumer pays."

There has been one industry which almost universally, has not been able to take advantage of this fact. We refer to the electric railway business and by this we mean railways and railroads which are using electricity as the motive power, but which have not been under government regulation. Costs on electric railways, subways and elevated lines, have been increasing for the past ten years. The attention of every person interested in the management and operation of these lines has been directed to the necessity of decreasing these costs. Every factor entering into the operation has increased in cost continuously, enormously, so that the cost per car mile has been increasing without a corresponding rise in the unit fare.

There has been, during this period, a great improvement in electrical apparatus, so that new equipments are more economically generated, and distributed electric power is produced from fewer pounds of coal, and therefore at less cost. New mechanical devices have been brought out which under normal labor conditions would reduce the maintenance costs of the mechanical and engineering departments. But with all of the more efficient apparatus used, the expenses have increased out of all proportion to the receipts and it has been necessary to look to other fields for the desirable and even imperatively urgent economies. Some economy has been obtained by checking more carefully the materials and the methods employed in various departments and by rearranging operating schedules on a more scientific basis.

There is another way to gain some of the greatest percentage in economy, and that is by reducing the waste of electrical energy in the transmission from the power house to the electric train and at the electric train. One of the largest items in the cost per car mile, is the cost for the electric power, so that a saving in this item, has a large percentage of saving in the total cost per car mile. The savings in transmission can be obtained by the use of the proper number and size of copper feeders and the location of substations, so that the loss of power in transmitting it from the power house to the trains will be not more than is warranted by circumstances. The saving of power at the car can be obtained by enlisting the intelligent co-operation of the motorman who directs its ultimate consumption.

It is this saving of the power at the car, that we are interested in. How can the motorman be made to substitute brains for sheer muscle? It is an admitted fact that ordinarily a large part of the total electrical energy is wasted daily on nearly every railroad in the country, compared with what would be the most efficient operation. The loss is due to the variable handling of the cars by the motorman, not necessarily through carelessness on his part, but from lack of information or of any adequate conception of what can be obtained by correct operation of the controller and brakes. He may be a good motorman, but he has been placed in charge of a train without a thought as to what degree of economy he can exercise. He often falls into a perfectly human "habit" of operation without regard to the power he is using.

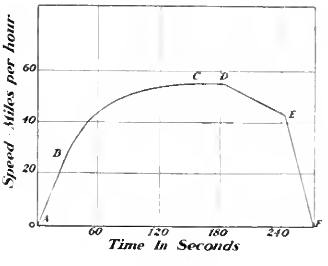


FIG. 1.

The officials of the Interborough Rapid Transit Co. of New York, who manage and operate the extensive subway and elevated lines, in that city, recognized the value of this power saving. They realized that some assistance must be given to the motorman whereby he could know whether he was operating economically or not; so that he could compare one run on a given section with another similar run, and draw comparisons.

They, with the directing mind of the vice-president leading, developed and put in operation on this road, the Rico Coasting Recorder. It is an instrument which records the actual number of minutes that the train is operated without the use of power or brakes. It is an efficient and desirable device and secures very great economy in operating railway equipments. It reads in "coasting minutes" delivering a printed voucher-slip to the motorman at the end of each run. This voucher-slip shows the degree of economy which the motorman has exercised on every run. By a system of ranking and rewards, the railway company may make a practical and monetary inducement to the men for economical operation, thus greatly reducing the amount of power ordinarily consumed.

How does a record of the number of seconds of coasting, have anything to do with the amount of electric power used? The operation of a train can be represented graphically by what is known as the speed time curve. The operation consists of a series of runs, the number depending on the number of stops which the train makes between the two terminals. At each stop the train starts from standstill, some resistance being used to regulate the current, it increases its speed or accelerates at first rapidly and then more slowly until a balanced speed is reached, or a speed sufficient to maintain the schedule. The power is cut off when necessary and the train coasts until a point is reached where brakes are applied, to bring the train to a halt at the next station. Each of the cycles of operation can be shown graphically by plotting speed against time as shown in Fig. 1. Acceleration is shown by the line ABC where AB is a straight line acceleration (constant rate) and this is the speed during the time that the resistance is being cut out step by step; the constant speed by line CD; coasting by DE; and braking by EF.

The energy input to a car or train is utilized to overcome the resistor losses in starting, to overcome the losses in the motors and wiring, to impart velocity to the car, and to overcome friction. By far the larger part of the energy for a service with frequent stops is that required to impart velocity to the train. The momentum thus imparted to a train will keep it in motion for a considerable time after the power is shut off. Although coasting to a standstill is not practicable, improvement in economy of current consumption can be effected by the nearest permissible approach to this condition.

Acceleration may be rapid, it may be slow, or it may be variable. To obtain maximum speed at the earliest possible moment, and to reduce the resistance losses to a minimum, rapid uniform acceleration must exist. With rapid and uniform acceleration the greatest possible

amount of the energy input is consumed in propelling the train.

The stored-up energy may be expended in two ways—either by braking or coasting. If the car is not allowed to coast, then it is necessary to apply the brakes immediately on throwing off the power, in order to retard the train. This unnecessary use of braking power means, not only, a waste of stored energy of the train, which could have been used to propel it for a considerable distance, but it also means discomfort to the passengers together with an enormous increase in brake shoe wear and a consumption of air pump current. By anticipating the approaching stops and slow-downs and coasting up to them and by not keeping the power on up to the point where brakes are to be applied, the waste of power is eliminated. In other words the stored energy of movement is made an assistant instead of an opponent.

Increased coasting time of a run means, then, uniform acceleration, with a strict attention to anticipating stops and slow-downs and a reduction of brake applications. So that, any increase in coasting time must result in a considerable power saving. Just what this saving is has been proved by a series of elaborate tests. It is this—that there is an approximate one to one relation between the rate of power consumption and the coasting percentage for any given run with any given train; that the rate of power consumption decreases in exact proportion as the percentage of coasting time increases. This fact means, that increased coasting is reflected in the coal pile for it indicates that less power must be generated to meet the demands of the trains.

Before describing the construction of the coasting recorder it may be interesting to know what has been saved in terms of tons of coal by their installation. On the Interborough system subways and the elevated roads this saving amounts to approximately 84,000 tons of coal per year. On the elevated and subway systems of Boston, Chicago and Greater New York, where the recorders have been installed, there is a reported saving of over 150,000 tons of coal per annum.

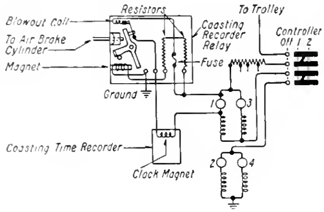


FIG. 3.

While the primary object of increasing the coasting is to accomplish a reduction in power costs, there are other benefits, which result in savings, which are obtained. One of these additional benefits is the reduced brake shoe wear. There are few brake applications, and these applications are made at a lower speed and where abrasion of wheel tread and shoe is comparatively low. This brake shoe saving may be as high as 50 per cent.

The coasting recorder simply consists of a recording mechanism shown in Fig. 3 and an electric relay. One recorder and one relay are necessary for each car or each multiple-unit train. The recording mechanism consists of a specially-designed recording instrument somewhat similar to those in use for factory time keeping. The printing mechanism is controlled and driven by a double-spring marine-movement clock, especially designed to withstand excessive vibration and climatic variations. This clock movement is directly geared to the recording mechanism and both are mounted on a solid cast-steel frame and enclosed in a steel case. Each motorman is given a registration key, bearing his badge number. With this key he registers at the beginning and end of the trip.

The clock is started electrically at the instant power is thrown off the train and remains in operation until train coasts to a stop, or until the brake is applied, or until the power is again turned on. The time the clock has operated during a trip is graphically shown by the difference between the initial and final readings of the impressions that the motorman takes on the paper tape contained within the recorder case, the movement of the type wheel that prints these impressions is governed by the movement of the clock itself.

An examination of the schematic diagram, Fig. 4, shows that the current can reach the controlling magnet on the clock movement only when the traction motors are running as generators; the back e.m.f. or generated voltage of the motors when coasting furnishes energy for the clock magnet. The magnet and brake attachment is so arranged that it can be adjusted to meet any operating condition.

The electric relay is so arranged that when the controller is "on" no current can get through to the clock magnet from the traction motors. When the brakes are applied the clock circuit is opened. Consequently a motorman must have the car moving without power or brakes on in order to operate the clock.

With this type of relay it is impossible for a motorman to "coast to a standstill" and obtain a fictitious record, as the energy which operates the clock magnet ceases when the motor stops. There is no evasion of this evidence of reality, and there can be no sinister discrimination or sentimental feeling on the part of this very ingenious piece of mechanism which the electric fraternity owes to the work of Mr. Frank Hedley, of the New York Interborough Railways in conjunction with Mr. J. S. Doyle, Superintendent of car equipment. The coasting clock records facts which show the dollar-and-cent advantage of efficient operation, and a competent and thoughtful motorman can effect a substantial saving for the company, and if he applies himself he can do this without necessarily inflicting the unpleasant jerking and rocking sensation of a too sudden start or a precipitate stop.

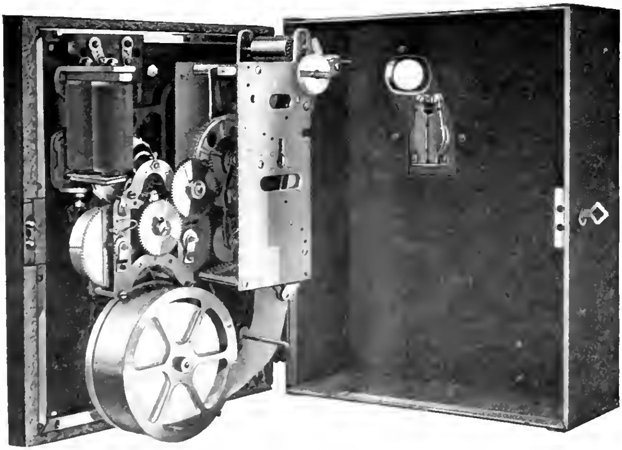


FIG. 2

Shop Foreman Organizing.

An organization is on foot among the railroad shop foremen and assistant foremen in the United States for mutual benefit. The chief grievance of the foremen is that many shop men under them, by working overtime, earn more than the foremen. The foremen, having had no organization, have had no voice in union affairs or in wage advances.

Gas Welding Methods

By J. F. SPRINGER

Oxy-acetylene welding is something that touches pretty much every important line of activity having to do with metals. The building and repair of locomotives and other railroad rolling stock constitute a large field of operations. The construction and repair of automobiles and motor trucks, provide another. The manufacture of non-ferrous utensils and applications to brass, copper and aluminum work provide still another. The oxy-acetylene torch is, in fact, one of the great instruments of construction and repair nearly everywhere that the leading industrial metals are used.

It is a remarkable instrument in repair, since it is able not only to unite metals but to replace lost parts. Its portability enables it to lend itself particularly to repair work. When the plumber is, with its aid, able to go into residences and public buildings and on the spot repair breaks in cast-iron pipes, etc., and other metals that have hitherto been difficult to handle, we have a proof of the merits of the repair process. The oxy-acetylene process is the procedure which can reach such cases.

The amateur machine room, the big machine shop, the foundry, the railroad roundhouse, the plumber's shop, the factory, turning out miscellaneous non-ferrous work—all these, and others, have use for the oxy-acetylene torch, for the reason that they are often "up against" problems which the oxy-acetylene torch can and does solve. A very important line of activity in which oxy-acetylene welding has been found to be of value is of welding sheet metal. Such work as welding the seams in the nickel-plated containers of the Edison storage battery is just the kind of work in which the oxy-acetylene process is very valuable.

Both in new and repair work, the process is a most hopeful adjunct; it must, however, be intelligently used. It is the purpose of the short series of articles now begun to set forth the fundamental methods of handling this kind of work. Those interested are urged to read, attentively, to skip nothing, whether it appears useful or not at the time.

Oxy-acetylene welding is carried out, ordinarily, by means of a torch or blowpipe held in the hand. There are two gases passing through the instrument and issuing from the burner. These are oxygen and acetylene. A double flame is formed. The inner white flame is quite small and may be only ¼ or ⅜ of an inch long. The outer flame is quite large and forms a kind of envelope. It is with the tip of the little white flame or a spot near the tip that the work is chiefly done. Here we have a temperature of something like 5,000 or 5,500 degs. Fahr., or perhaps more. It is largely because of the enormous temperature that work covering a wide range may be done.

In fact, all the usual industrial metals yield to this temperature. There is no trouble in melting gold, silver, iron, cast iron, steel, copper, brass, bronze, aluminum, tin, lead, etc. Consequently, the oxy-acetylene torch has a very wide variety of uses. Cast-iron was one of the first materials dealt with commercially. Almost any break in cast-iron may be repaired. For example, if a low-pressure steam radiator unit has cracked from any cause—say from the freezing of contained water—the oxy-acetylene process is able to have repairs made. Furthermore, unless the break is at some inaccessible point, the torch, together with the oxygen and acetylene supplies, may be brought to the spot and the radiator repaired not only without removal but without dismantling. Again, suppose a brass casting on a locomotive breaks. This is also a job for the oxy-acetylene torch. If conditions permit, the repair may be made without removal of the two parts.

WELDING OPERATOR AT WORK, TORCH IN RIGHT HAND, WELDING ROD IN LEFT.

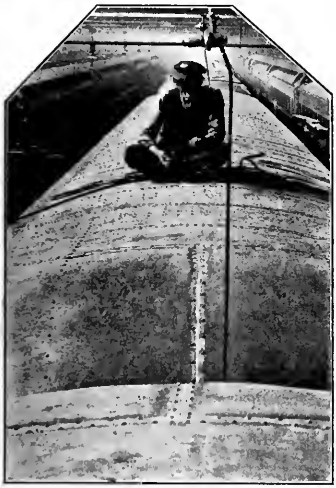
A break may occur in a steel plate in a locomotive fire-box. This is a repair which has often been made with the oxy-acetylene burner. In fact, in a case like this, the process comes in in a double manner. That is to say, by means of a suitable compound torch or a suitable attachment to the welding torch, the process may be utilized to cut out the damaged steel plate as well as to weld up seams between plates. A high pressure jet of pure oxygen associated with the ordinary oxy-acetylene welding flame enables the operator to cut steel, both thick or thin, both cast or rolled. Steel may be cut but no other metals.

To go back to the simple welding operation. It may often be used to build up a part that has been broken off and lost. It may be a bronze or a brass knob, or part of the control wheel or other device attached to a valve. In such cases, if conditions are favorable, the oxy-acetylene process may be brought in not merely to secure the two pieces together but to build up the whole of that which is lost and gone. The powerful little white flame melts off brass or bronze from a rod of the material and enables the operator to build up and fashion the lost part—to add it to the main portion. This may at times be done without removing anything. The finishing of the new piece is a job for the file and for similar tools.

Let us suppose, for example, that a casting has been broken across. It does not matter whether it is cast-iron, brass, aluminum, or steel, the oxy-acetylene process is well adapted to mend the break and unite the two parts. It does not matter whether the casting is a small one, such as a radiator unit, or a part belonging to the steam plant in the basement of an apartment house. Or it may be a frame or a bracket belonging to a railway locomotive. It may possibly be a big casting, such as the base of a large machine. Big or little, it is all the same to the oxy-acetylene process. The casting may be new and still in the shop; it may be old and at the bottom of a pit. New or old, under shelter or out of doors, near the shop or far from it, the casting can be repaired. Torches may be taken to the work and also tanks containing the gases oxygen and acetylene. Or the work may be brought to the shop. Some shops have acetylene piped to various points of convenience and secure it by flexible or other branch piping. The job in hand may require that a malleable iron piece be secured to a rolled steel part; or it may be that a piece of hard brass needs to be united to a soft brass part,

it is a job for the oxy-acetylene process. Whether the operator can do it or not will depend largely on how much he knows about the process.

There are, naturally, some jobs that can be handled by any process. The break, for example, may be located where neither the oxy-acetylene torch nor any other instrument doing similar work can be inserted. In short, the job may be out of



WELDING ROOF JOINT TIGHT ON A STEEL PASSENGER CAR.

reach. Then there are jobs which can be done, but require more than ordinary skill and knowledge. Just an ordinary welding man could hardly be expected to weld up a break in a high pressure copper steam pipe on an ocean liner, that takes skill and knowledge. But there is such an enormous amount of new and repair work that the ordinary oxy-acetylene welder really can do and do acceptably that we need not be troubled if some jobs are beyond the man.

The great power of the oxy-acetylene flame is the thing that enables it to conquer any ordinary metal. But this power is, at the same time, the thing that will make trouble for the careless workman. The very ease with which metal may be melted, makes it necessary to be on the watch lest the flame be allowed to do too much. Thin metal whose melting temperature is rather low, needs to be handled wisely, otherwise, damage to the metal will be done. So it will be well for the beginner to face the fact that oxy-acetylene welding is an art to be studied seriously and not just picked up by watching someone else at work. What the welder needs to know is the construction and mode of operation of his torch; the methods that have been found adapted to various classes of work; and the reasons for the various rules and directions.

Just now, let us pay some attention to the flames which issue, as it were, from the torch. The little white flame constitutes the welding tool. Ordinarily, the tip of this flame is what is used. The tip marks the hot spot. The character of the flame closer to the burner and farther away, is different from what it is at the region of the tip end. Nearer the burner, there are understood to be three gases flowing—oxygen, gaseous carbon, and hydrogen. The oxygen will generally be undesirable for contact with hot metal. The carbon will also be undesirable, but perhaps for a less number of jobs. The hydrogen will often do no harm. If the reader has grasped the point here, he will readily understand that he should be on his guard lest this part of the flame flow onto the work. Further out from the burner, at points beyond the end of the tip of the white flame, the conditions are more favorable. In fact, all this region, including the big enveloping flame, acts as a protection to the hot metal. It is eager for oxygen and readily licks it up, whether the oxygen be oxygen that has come through the torch and has failed to unite with either the carbon or the hydrogen, or whether the oxygen comes from the surrounding atmosphere.

Welding in Railway Service.

The Sayre shops of the Lehigh Valley Railroad claim the distinction of having turned out, about five years ago, the first completely welded firebox placed in service on an American railroad, and the plant is still turning to good account the economies possible through the use of oxy-acetylene and electric welding.

So far have improved methods of doing boiler work progressed at this plant that locomotive fireboxes are regularly renewed without removing the boiler from the frame, it being the practice to cut out the original firebox and put in in three sections, welding up all seams and joints. Among other expedients employed is that of dispensing with the studs at the corners of the mud rings, the practice being instead to countersink holes through the firebox sheets and into the mud rings sufficiently to get clean metal, and then spot weld the sheet to the mud ring by filling up the holes with the welding torch.

It has also become the regular practice to reclaim car and tender axles having worn collars by the oxy-acetylene torch. The collar is built up the required amount, and then machined to the standard contour. In case the material deposited is found to be too hard, resort is had to the process of annealing the ends of the axles to enable the lathe tool to take hold. The expense involved in this process is given as $2.34, as compared with $20, the approximate cost of new axles for 50-ton cars. In cases where the rocker or tumbling shafts of locomotive valve gear mechanisms have become worn these parts are built up to size and restored to service at a fraction of the expense involved in renewing them. Loose fits on the crankpins and driving axles of locomotives are similarly treated. Locomotive driving box shoes are attached in the same manner as are the firebox sheets at the corners of mud rings—that is, by spot welding.

Cracked cylinders, which to replace new would cost anywhere from $800 to $1,200 are restored to service by autogenous welding at a cost that is insignificant in comparison. Broken engine frames are regularly welded in place, and miscellaneous lugs and brackets, including those on air pumps, are also restored by this means. A further economy to be observed at the Sayre shops and one in which the oxy-acetylene torch plays its part is the cutting out of blanks from old boiler shells from which locomotive driving brake heads are pressed in the bulldozer. The expense of making these heads amounts about 35c. each, as compared with more than $2, the present cost of these part if made from malleable iron or steel castings. So fully is the value of autogenous welding appreciated by the mechanical staff of the Lehigh Valley Railroad that part of the standard equipment at each of its modernized engine terminals consists of an electric welding equipment with its automatic control panels.

Care of New Belts.

Belts, in many respects, are like most other pieces of machinery. They "settle down" only after use. If well maintained they will run better the second year than the first.

Most belt troubles are caused by early neglect. The good that is in the belt is quickly lost unless some attempt is made to keep it there.

The best way to keep the good in a belt is to make the belt even more pliable than when new. Do not allow it to slip at any time, for slip generates heat and heating is hard on all belts—old as well as new. The belt becomes charred, hard, and can never be rejuvenated. The good is gone forever. Proper treatment when the belt is new is the only protection against this effect.

Again, if the belt is not treated when new, and even if it does not slip, there is a certain amount of internal wear produced by one dry fibre sliding and grinding against the other, which leads to early self-destruction. If these fibres are lubricated when the belt is new, there can be no grinding and wearing out.

Of course, the belt must be treated from time to time thereafter just as any machine must be oiled from time to time, but a machine does not need as much oil after it has settled down as when new. The same is true of belts.

Items of Personal Interest

Mr. Harry Neinbore has been appointed machine shop foreman of the Southern Pacific at Portland, Ore.

Mr. M. S. Montgomery has been appointed fuel supervisor of the Northern Pacific, with headquarters at St. Paul, Minn.

Mr. Fred Berglund has been appointed roundhouse foreman of the Chicago, Milwaukee & St. Paul, with office at Milbank, N. D.

Mr. William Casey, formerly manager of the Canadian Locomotive Company, Ltd., Kingston, Ont., has been appointed general manager.

Mr. Henry Jesberg has been appointed assistant boiler shop foreman of the Chicago, Milwaukee & St. Paul, with office at Minneapolis, Minn.

Mr. Charles B. Anderson has been appointed assistant blacksmith foreman of the Chicago, Milwaukee & St. Paul shops at Minneapolis, Minn.

Mr. A. J. Lewis, formerly general foreman of the Missouri, Kansas & Texas of Texas, has been appointed shop superintendent at Denison, Tex.

Mr. S. W. Fryer has been appointed general foreman of the Southern Pacific shops at Portland, Ore., succeeding Mr. George Hammond, promoted.

Mr. T. E. Cullen has been appointed assistant master mechanic of the Erie at Briar Hill, Youngstown, Ohio, succeeding Mr. R. R. Munn, resigned.

Mr. A. L. Brown has been appointed master mechanic of the Chicago, Milwaukee & St. Paul at Savanna, Ill., succeeding Mr. J. T. Lendrum, resigned.

Mr. G. B. Small has been appointed superintendent of the fire hose and protection department of the Great Northern, reporting to the general manager.

Mr. Henry E. Wienke has been appointed machine foreman of the Huntington, Ind. shops of the Erie, succeeding Mr. Charles Clabaugh, transferred.

Mr. Nelson T. Burns, formerly with the New York Central, has joined the sales department of the Vapor Car Heating Company, with office in Chicago, Ill.

Mr. Erik W. Lostrom has been appointed road foreman of engines of the Northern Pacific, with office at Duluth, Minn., succeeding Mr. Charles Emerson, promoted.

Mr. Nelson T. Burns, formerly with the New York Central, has entered the sale department of the Vapor Car Heating Company, Inc., with headquarters at Chicago.

Mr. Charles E. Peiffer, formerly general car supervisor of the Buffalo, Rochester & Pittsburgh, at Du Bois, Pa., has been appointed master car builder, with headquarters at Du Bois.

Mr. J. L. Riley, formerly general foreman of the Chicago, St. Paul, Minneapolis & Omaha, at Sioux City, Iowa, has been appointed master mechanic at Sioux City, succeeding Mr. J. O. Enockson.

Mr. C. N. Bainbridge, formerly assistant engineer on the Chicago, Milwaukee & St. Paul, has been appointed engineer of design, with headquarters at Chicago, succeeding Mr. H. C. Lothholz, resigned.

Mr. L. W. Barr has been appointed general roundhouse foreman of the Erie, with office at Meadville, Pa., and Mr. A. Lutton general foreman, and Mr. W. H. Harris, piecework checker, both at Meadville.

Mr. W. C. Burel has been appointed master mechanic of the Pittsburgh division of the Baltimore & Ohio, Eastern Lines, with headquarters at Glenwood, Pa., succeeding Mr. A. H. Hodges, transferred.

Mr. Charles W. Weeks has been appointed road foreman of engines on the Toledo division of the Pennsylvania, western lines, with headquarters at Toledo, Ohio, succeeding Mr. R. Palmer, promoted.

Mr. L. C. Clamblitt, formerly assistant road foreman of engines of the Baltimore & Ohio, Eastern Lines, with office at Cumberland, Md., has been appointed road foreman of engines with headquarters at Keyser, W. Va.

Mr. J. O. Enockson, formerly master mechanic of the Chicago, St. Paul, Minneapolis & Omaha at Sioux City, Iowa, has been appointed superintendent of motive power and machinery, with headquarters at St. Paul, Minn.

Mr. W. J. Robider, formerly master car builder of the Central of Georgia, has been appointed general master car builder of the Canadian Pacific, with headquarters at Montreal, succeeding Mr. C. W. Van Buren, deceased.

Mr. G. E. Murray, formerly chief electrician of the Chicago & North Western, with headquarters at Chicago, has resigned to become electrical and mechanical engineer of the Grand Trunk, Western Lines, with headquarters at Battle Creek, Mich.

Mr. Roswell P. Cooley, of the Vapor Car Heating Company, formerly in charge of sales in the southwestern region, with office in Chicago, has been appointed Eastern sales manager, with office at New York City, succeeding Mr. George T. Cooke, resigned.

Mr. N. B. Emley has been appointed fuel supervisor of plants and shops of the Erie, with headquarters at Meadville, Pa., and will supervise the handling and economical use of fuel at all power plants and shops in the system; report to Mr. G. Trumbull, assistant to the general mechanical superintendent.

Mr. E. H. Coapman, Federal manager of the Southern and associated lines, with headquarters at Washington, D. C., has been appointed Federal manager also of the Georgia Southern & Florida, the Hawkinsville & Florida Southern, and the St. Johns River Terminal.

Mr. G. W. Seidel, formerly superintendent of motive power of the Minneapolis & St. Louis, has been appointed superintendent of Chicago & Alton, and the Chicago, Peoria & St. Louis, with office at Bloomington, Ill., succeeding Mr. J. E. O'Hearne, resigned.

Mr. W. I. Jeffards, formerly assistant chief draftsman of the Erie, has been appointed resident engineer at Meadville, Pa., in charge of engine terminal facilities now in course of construction there, consisting of engine house, machine shop, storehouses, coaling plant and ash handling facilities.

Mr. R. W. Burnett, formerly shop superintendent of Missouri, Kansas & Texas Railway of Texas, at Denison, Tex., has been appointed mechanical superintendent of the Missouri, Kansas & Texas and the other roads under the jurisdiction of Mr. J. S. Pyeatt, federal manager. Mr. Burnett's headquarters are at Denison.

Mr. G. R. Galloway, formerly master mechanic of the Baltimore & Ohio, western lines, with office at Lorain, Ohio, has been appointed master mechanic of the western lines of that road, the Dayton & Union, and the Dayton Union railroads, with headquarters at Cincinnati, Ohio, succeeding Mr. P. H. Reeves, assigned to other duties.

Mr. J. A. Tschwor, formerly general foreman of the locomotive department of the Baltimore & Ohio, western lines, with headquarters at Willard, Ohio, has been appointed master mechanic of the New Castle division, succeeding Mr. M. A. Gleeson, transferred to the Cleveland division, succeeding Mr. G. R. Gallaway, promoted.

Mr. Roswell P. Cooley has been appointed Eastern sales manager of Vapor Car Heating Co., Inc., with office at 50 Church Street, New York, succeeding Mr. George T. Cooke, who recently severed his connection with the company. Mr. Cooley has had charge of sales in Southwestern Region, with headquarters at Chicago.

Mr. J. M. Hannaford, Federal manager, announces that Mr. F. G. Preest will have charge of the purchasing and stores department of the Northern Pacific, the Minnesota & International, the Big Fork & International Falls, and the Camas Prairie, with headquarters at St. Paul,

Minn., who will appoint a general storekeeper and other necessary assistants.

Mr. Charles A. Howe, purchasing agent of the Missouri Pacific, the St. Louis Southwestern and the Louisiana & Arkansas, with headquarters at St. Louis, Mo., has had his jurisdiction extended over the Memphis, Dallas & Gulf, with headquarters at St. Louis.

Mr. R. D. Quickel has received an honorable discharge from military service, and been re-appointed fuel agent of the Southern lines and associated railroads, lines west, with headquarters at Cincinnati, Ohio, succeeding Mr. W. C. Kieffer, assigned to other duties.

Mr. Charles F. Quincy has been elected president and Mr. Frank F. Kirten has been elected secretary-treasurer of the Q and C Company of Canada, Limited. The company has been incorporated and will manufacture and sell in Canada railway devices controlled by the Q and C Company. The Canadian representatives are the General Supply Company of Canada, Limited, 356 Sparks Street, Ottawa.

Mr. H. R. Barten has been appointed general fire prevention inspector of the Missouri Pacific, the St. Louis Southwestern, the Louisiana & Arkansas, the Memphis, Dallas & Gulf, the Arkansas Central and the Natchez & Southern railroads, the Southern Illinois & Missouri Bridge and the Coal Belt Electric, with headquarters at St. Louis, Mo., reporting to the chief engineer.

Mr. J. T. Carrol, mechanical assistant to Mr. Charles H. Markhan, regional director of the Allegheny region, United States Railroad Administration, has been appointed general superintendent maintenance of equipment of the Baltimore & Ohio, Eastern Lines, the Coal and Coke, the Wheeling Terminal, the Western Maryland, the Cumberland Valley and the Cumberland & Pennsylvania, with headquarters at Baltimore, Md., succeeding Mr. J. H. Clark, resigned.

Mr. L. H. Turner, recently appointed as superintendent of motive power of the Pittsburgh & West Virginia, and the West Side Belt, has also been appointed superintendent of motive power of the Monongahela, with headquarters at Pittsburgh, Pa. Mr. Turner is from Macedon, N. Y., and has had an interesting career as a railroad man in the mechanical department. Beginning as a rivet heater on the Lake Shore & Michigan Southern, he later entered as an apprentice in the machine shops at the Elkhart shops. Gang foreman for four years, and foreman at the shops of the Air Line Junction. In 1874 at the age of 22, he was general foreman of the shops at Norwalk. In 1887 he was appointed superintendent of motive power on the Pittsburgh & Lake Erie, and has now completed 50 years of continuous service with the New York Central Lines. By right of seniority, he is now dean of superintendents of motive power in the United States.

Mr. R. W. Burnet, formerly master car builder of the Delaware & Hudson, has resigned to become assistant to the general manager of the Joliet Railway

L. H. TURNER.

Supply Company, and vice-president of the National Car Equipment Company, with headquarters at Chicago. Mr. Burnet has had an extensive experience as a master car builder, both in the Middle West, in Canada, and also in the Eastern States, being several years master car

R. W. BURNETT

builder on the Erie. Mr. Burnet left railroad work in 1915 to become vice-president of the National Car Equipment Company, but in 1917 was appointed master car builder on the Delaware & Hudson, from which position he has now resigned.

The Air Brake Association.

At a meeting of the Executive Committee of the Air Brake Association, held in Pittsburgh, Pa., on December 5, President F. J. Berry presiding, Chicago was selected as the meeting place of the 26th annual convention of the association, the meeting to be held on May 6, 7 and 8, 1919. It was decided on the Wednesday afternoon during the sessions of the convention, an informal meeting be held, conducted by a junior officer, for a free informal discussion of any subjects brought up. It was believed this would bring out information not obtainable on the floor of the reported convention, and would also encourage younger members to speak their minds freely.

Mr. L. P. Streeter was elected to serve as general chairman on the Committee of Arrangements, he to select his own committee, presumably local Chicagoans, and others who might assist him in any way in the convention work. Mr. Streeter's supervision will cover exhibit and other arrangements as well as the work arrangements of the convention.

It was decided to issue invitations to the various air brake clubs throughout the country to meet with the Recommended Practice Committee, as was done in Cleveland this year, with a view of molding into shape the Recommended Practice Committee report. It is thus hoped to settle in committee meeting the many matters which could not, because of limited time, be discussed freely on the floor of the convention.

It was also decided to invite the car builders and locomotive builders to send such a representation to attend the convention, the object being to familiarize the builders with the latest and most advantageous methods of air brake installations of equipment.

The convention subjects adopted by the committee and referred to special committees are as follows: "Air Requirements for Pneumatically Operated Devices for Locomotives," C. H. Weaver, chairman; "Cleaning, Repairing, Lubricating and Testing Freight Car Brake Cylinders," by Mark Purcell; "Reclamation and Conservation of Air Brake Material," T. L. Burton, chairman; "Twenty Per Cent. Overload Allowed on Heavy Grade Braking," by G. H. Rawlings; "Holding Standing Trains and Cars in Grades," by R. J. Watters; "Recommended Practice," H. A. Clark, chairman; topical subject, "M. C. B. Air Brake Defect Card," by J. Elder; topical subject, "How Can Enginemen and Trainmen Assist in Air Brake Maintenance?" B. H. A. Glick.

Some children used to disappoint their parents when they grew up. But nowadays it is the other way.

Obituary—Angus Sinclair, D.E.
Engineer, Editor, Author

It is with a feeling of profound sorrow that we record the death of Angus Sinclair, D.E., founder, and editor-in-chief of RAILWAY AND LOCOMOTIVE ENGINEERING for the last thirty-two years. The sad event occurred on January 1, 1919, at his home in Millburn, N. J. Dr. Sinclair had been in failing health partly from intermittant spells of acute rheumatism complicated with gastritis. He had decided to make his usual sojourn in Florida during the winter months, but his maladies assumed a more serious form about the end of November, and after a month's lingering illness his fine physique and bright spirit succumbed to the insidious complication.

Dr. Sinclair was a native of Forfar, and was reared in Laurencekirk, Scotland. His father came from the Highlands when railway construction work began in the Northeast of Scotland, and as a section foreman he was said to be a model of intelligent industry. Angus was the oldest of four sons, and began his railroad career as a telegraph operator, and latterly learned engineering at the railway shops of the Scottish Northeastern Railway at Arbroath. While running a locomotive on the road he attended the evening high school, and passed a high examination in the Civil Service, and was employed for several years on the Customs Department in Montrose, and in London, England.

The love of adventure took him to sea, and after some service as a marine engineer, he again took up railroading in America. After some experience on the Erie Railroad he went west and ran a locomotive on the Burlington, Cedar Rapids and Northern. During this period he attended the chemistry classes of the Iowa State University, making a specialty of water analysis, and was appointed chemist on the railway, combined with the duties of roundhouse foreman. It was during this period that he first gave serious consideration to the problem of fuel economy and smoke prevention. His methods met with considerable opposition but are now universally approved, and it is not too much to say that the rapid promulgation of his views, as set forth in his numerous publications, many of which became textbooks, have been the means of saving millions of dollars to the railroads.

His contributions to railway and other publications attracted wide attention and in 1883 he joined the editorial staff of the *American Machinist*. A few years later he became president of the publishing company, and latterly became proprietor and editor of RAILWAY AND LOCOMOTIVE ENGINEERING. His first published work "Locomotive Running and Management," was begun while running a locomotive, and was made up entirely from personal observation. He early exhibited a clearness of style, and an engaging descriptive fluency not common in engineering works. His first book has passed through twenty-six editions, and has been repeatedly revised by the author, the latest revision appearing in 1915, so that this notable and popular book may be said to be the first and last of his eminent literary labors.

This work was followed in rapid succession by "Combustion in Locomotive Fireboxes," "Firing Locomotives," "Railroad Man's Catechism," "Twentieth Century Locomotives," and "History of the Development of the Locomotive Engine." Those works have all passed through extensive and numerous editions. Among these the work on "Firing Locomotives" was translated into eight languages, including Chinese.

In 1908 the President and Faculty of Purdue University, Lafayette, Indiana, conferred upon Mr. Sinclair the honorary degree of Doctor of Engineering. About this time he was also appointed special technical instructor in the mechanical department of the Erie Railroad. In the class rooms of railroad apprentices and in railroad clubs and societies generally, he was a ready and fluent speaker, his platform addresses having the same direct and interesting features that distinguished his work as an engineering writer. He travelled extensively in Europe as well as in America, and was everywhere received as among the foremost authorities on all matters connected

ANGUS SINCLAIR, D.E.

with the mechanical department of railways.

Mr. Sinclair's originality of thought and keen habits of observation constantly led him into innovations. In his experience in the West the digging of wells for water among the limestone formation had the effect of cementing the flues with a degree of rapidity that would be difficult to surpass. He soon convinced the higher officials of the railroad of the absurdity of digging wells while comparatively pure water was flowing abundantly in the neighboring streams. He had more opposition from the firemen, the early method, as is well known, being to stuff the firebox full of coal and then sit down and watch the passing panorama under a pillar of cloud. He is universally conceded to be the first to advocate the system of thin and continuous firing, which has reached perfection by the use of the mechanical stoker.

On the introduction of the air brake, Mr. Sinclair was called by George Westinghouse, the inventor of the new braking system, to accompany a special demonstration train that ran for many weeks over the principal railroads, demonstrating the efficiency of the device. Here Mr. Sinclair did great work. He fairly filled the American press with details of the air brake operation. At every town he gave the newspaper men more "copy" than they could print. It was a happy mixture of scientific facts with such fancies and moving incidents that caught the attention of the general reader as well as the more serious attention of the cautious railroad man.

His crowning success, however, was in RAILWAY AND LOCOMOTIVE ENGINEERING. In a few years it was recognized a leading authority in railway mechanical department matters, and has maintained its high character and standing ever since. Mr. Sinclair's idea of combining a trade journal with educational features was amply vindicated by the marked success and sustained popularity that has attended the publication. As may be expected Mr. Sinclair could not sustain this work alone. He had the happy faculty of choosing able assistants or what is perhaps as good, he could make a good man out of raw material, if the right material was there. Nearly all of his associates have risen to distinction in the field of engineering journalism, and all have admitted the value of their collaboration under Mr. Sinclair's kindly management.

Among these may be mentioned the late John A. Hill, for many years proprietor of *The American Machinist*, and other publications; Fred A. Colvin, author of various engineering books, and latterly editor of *The American Machinist;* Fred M. Nellis, Secretary of the Air Brake Association; editors and technical engineering writers, W. B. Kouwenhoven, Fred A. Halsey, William A. Baker, Frank T. Hemenway, George S. Hodgins; air brake experts, the late Clinton B. Conger, the late George W. Kiehm and J. P. Kelly, and James Kennedy, managing editor of RAILWAY AND LOCOMOTIVE ENGINEERING, and the writer of this obituary article.

It should also be noted that during this long period of intellectual and physical activity, Mr. Sinclair has been closely identified with the work of nearly all of the leading engineering societies in America, and with some of the same kind in Europe. He was the senior officer in point of continued service in the America Master Mechanics' Association, and has been prominently identified with the Master Car Builders' Association, the Brotherhood of Locomotive Engineers, as well as the leading railroad clubs. As a juror at the various International Expositions during the last thirty years his services have been urgently demanded and warmly appreciated.

In his kindly relations toward the less fortunate and perhaps, less enterprising, their various demands never hardened his heart to the deserving and even to the undeserving, and the success that attended his life's work neither gave him a swelling of the head nor its resulting equivalent of a contraction of the heart. An example of self reliance and self respect, he often sought out the unfortunate and steered them to such success as they were capable of achieving, and it was immaterial whether they came back to thank him or not. He passed through the fiery furnace of competition in his youth and early manhood with limited equipment, and loved to help those that gave promise of helping themselves, and had his reward in seeing many of them sustain his recommendations.

It may be added that of the four brothers all rose to more or less distinction. William became Professor of Gynecology in Owen's College, Manchester, England, and was knighted for meritorious services by Edward VII. Donald, like Angus, came to America and engaged in railway and tunnel construction, and among other works, completed a part of the drainage canal at Chicago. Alexander, the youngest, was for many years employed in the Government service in Glasgow, Scotland, and contributed extensively to the Scottish press. Mr. Sinclair was married twice, first to Margaret Moore, the daughter of a farmer in Iowa. The lady's health failed in middle life, but she lived long enough to share Dr. Sinclair's good fortune and enjoy many of the social distinctions that came to him. Later in life Dr. Sinclair married Medora Head Mullin, a lady of high attainments, and in their delightful home at Millburn, New Jersey, many distinguished visitors have enjoyed their generous hospitality.

Dr. Sinclair was in the seventy-eighth year of his age, and may be said to have retained his remarkable faculties in an eminent degree to within a short period of his death.

Among the engineering and fraternal societies to which he was attached may be noted as already stated the American Railway Master Mechanics' Association, to which he was elected a member in 1873. He served as secretary of the association from 1887 to 1896, and was elected treasurer in 1900 and served continuously until the time of his death. He became a member of the Master Car Builders' Association in 1873, and the American Society of Mechanical Engineers in 1883. He was the first president of the New Jersey Automobile and Motor Club. He was a delegate to the International Railway Congresses held at Washington, D. C., St. Louis, Mo., and Berne, Switzerland.

Among the societies which he aided in establishing was the Traveling Engineers' Association, founded in his office in 1892. He was a Knight Templar in the Masonic fraternity, a Governor in the St. Andrew's Society, ex-President of the Burns Society, and also of the St. Andrew's Society of Newark, besides being a member of the American Railway Guild, Lawyers' Club, New York Railroad Club, and numerous other railway, Scottish and other societies.

In this hour of irreparable loss, a word may be said in regard to the future of RAILWAY AND LOCOMOTIVE ENGINEERING and his other numerous copyright publications. It may be stated briefly that it has been Dr. Sinclair's frequently expressed wish that they should be carried on in the name of the corporation which he established. It may be readily imagined that in his recent years and during his occasional absences his contributions to the pages of RAILWAY AND LOCOMOTIVE ENGINEERING have not been as frequent as formerly, but his constant care was to see that it was carried on with the same aim in view towards which it was originally devoted. The combination of a high class practical journal devoted to the dissemination of the best expression of the best thoughts of our time in relation to motive power, rolling stock and the mechanical appliances relating thereto, with clear descriptions of the same that may be readily understood by all railway men, together with such educational features as may meet the requirements of the time looking to the better education of the ambitious railroad man. To this end the periodical was established, and toward this aim it will be carried on. The editorial and general staff, selected and trained under his experienced eye, are in hearty accord with his views, and are already assured of the continuance of that support which was liberally extended to Dr. Sinclair in his long and notable career as a publisher of a high class trade journal.

Meeting of M. C. B. and M. M. Executive Committees.

A joint meeting of the Executive Committees of the Master Car Builders', American Railway Master Mechanics' and Railway Supply Men's Association, was held at the Biltmore Hotel, New York, on December 20, 1918. The following members were present: The Master Car Builders' Association: Messrs. C. E. Chambers, I. S. Downing, Jno. S. Lentz, F. F. Gaines, C. B. Young, T. H. Goodnow, Samuel Lynn, J. C. Fritts, Jas. Coleman, Frank McManamy. The American Railway Master Mechanics' Association: Messrs. J. W. Tollerton, C. F. Giles, W. E. Dunham, Jno. Purcell, M. K. Barnum, M. A. Kinney, H. C. Manchester, C. H. Hogan, R. L. Kleine representing J. T. Wallis, and Frank McManamy. The Railway Supply Men's Association: Messrs. E. H. Walker, J. D. Conway, J. G. Platt, Geo. R. Carr, Geo. O. Cooper, Chas. W. Beaver, Wm. McConway, Jr., Philip J. Mitchell.

It was decided that the convention be held along the same general lines as heretofore, with such modifications as may seem desirable, beginning on Wednesday, June 18, and continuing until June 25, 1919. It was also decided to invite the mechanical representatives of the allied and neutral foreign governments through the commercial representatives of the Embassies at Washington to participate in the convention, which will be held at Atlantic City, N. J.

The Master Car Builders' Association's convention will be held June 18 to 21, and the Master Mechanics' Association's convention from June 23 to June 25, inclusive. The Hotel Men's Association of Atlantic City assured the committee that the same arrangements as proposed in 1916 would be carried out.

Messrs. C. E. Chambers, F. H. Clark and E. H. Walker will have charge of all plans and arrangements for the convention.

Thin vs. Thick Belts in Railway Shops.

It seems that what looks like a very strong belt, that is one that is quite thick, may not be as good as a thinner one. The thick belt may be stronger in the sense that its tensile strength may be much greater than a thinner one. In that way it may be quite strong enough to stand up to the drag of the pulley, and yet this strong, thick belt may wear out faster than one not so strong or so thick. The reason for this is the use the belt is put to.

Belts of all kinds have to sustain the drag of the pulley, and must at least be strong enough for its work, but one may almost say that it is possible to make it too strong. This is not strictly accurate, but there are internal stresses set up in the belt by reason of its incessant bendings on each pulley and then being pulled tight between them. Width is not so important, if the belt is strong enough for its work, as its pliability, whereby it can stand constant bending and straightening without injury. It is well, however, where possible to use wide, thin belts rather than narrow thick ones. The narrow thin belt lasts longer than a thick one and probably costs less at the outset.

A practical example of what can be done at a pinch in an emergency may be given here. A factory was shut down by the main driving belt breaking repeatedly. It was got going by the use of stout roller towelling purchased at the local shop; it was certainly all single, and even so, thinner than ordinary. The pulleys driving various tools and machines were all of unusual width, and the practice of the machine tool maker was criticised on the ground that speed cones were invariably too narrow for the thin wide belt.

Leather can be had single or double, and there are processes of tanning which plump out the substance to obtain the greatest weight from the original hide. In judging between rival offers accompanied by small samples it needs caution, because the best color and substance do not guarantee the best article. The belt running over small pulleys stretches and grows thinner and thinner at each take up, is by no means uncommon, and, perhaps, these conditions are the worst possible. It is equally certain that a thick belt on small pulleys has no more adhesion than the thinner type, and slipping means speedy destruction. If for unavoidable reasons the width of the pulley must be limited, and the belt thickness increased to stand the load, the pulleys must be as large as possible.

Years ago when the propeller at the stern of a vessel was first tried, the propeller had a number of blades. These were put on, due to the idea that the more blades a propeller had, the greater power it would develop. By some accident one blade broke off and a slight improvement in speed was noticed. Another dropped off and greater speed was recorded. It dawned on ship builders that the propeller might be all the better with a limited number of blades, and finally three was the number decided on. The propeller was all the better, as formerly it churned the water into froth, and the froth gave way too fast to offer a comparatively solid wall of water for the propeller blades to push on.

Many machine tools have stepped pulleys too narrow on the steps. Where conditions are good, it is wonderful the length of time that a piece of first-rate belting will endure; it reaches years and serves for a length of time which may cause surprise in those quarters where belting costs a good deal of money.

Railroad Equipment Notes

The Monongahela Railway will build a one-story addition to its plant in South Brownsville, Pa.

The United Railways of Havana have ordered six locomotives from the American Locomotive Company.

The Shantung Railway of China has ordered five locomotives from the American Locomotive Company.

Pennsylvania Railroad is building a one-story engine house at its local yards at Trenton, N. J., to cost about $10,000.

The Constitutionalist Railways of Mexico have ordered eight Mikado locomotives from the Lima Locomotive Works.

Delaware, Lackawanna & Western will erect a car shed and repair shop at Buffalo, N. Y., at an estimated cost of $100,000.

The Southern Pacific will erect a steel foundry, repair shop and a parcel post building at Sacramento, Cal., at a cost of $80,000.

Maine Central has begun work on rebuilding the pattern shop and will erect new buildings for the same purpose at Waterville, Me.

The Mexican Petroleum Corporation, New York, has ordered 50 10,000-gallon capacity tank cars from the American Car & Foundry Company.

Rapid progress is being made on the erection of a roundhouse at De Forest Junction, Ohio, for the Baltimore & Ohio. The building when completed will cost $200,000.

The Secretary of War, in announcing the amount of some of the larger contracts cancelled by the War Department, mentioned an item of $53,000,000 for iron and steel products and railway materials.

A. G. De Sherbinin & Company, importers and exporters, 60 Broadway, New York, are asking prices on trucks for 50 10-ton 30-inch gage gondola cars, for two 15-ton 30-inch gage locomotives and for 12 miles of 30-pound rail for export.

The project of constructing a railroad along the Rio Grande, between San Fordyce, on the lower border, and Del Rio, a distance of about 500 miles, is reported to have been revived since the signing of the armistice.

The Russian Government has recently reinstated orders for 4,000 of the freight cars it had previously ordered and later cancelled. The American Car & Foundry Company will build 2,600 and the Standard Steel Company 1,400.

The United States Railroad Administration has prepared designs for 375 standard type passenger cars and 129 combination passenger, baggage, mail and express cars, and specifications will soon be issued on 886 baggage cars of the 60-foot and 70-foot types.

The Danish State Railways for a long time have been in need of more freight cars and have now ordered 750 from the "Scandia" factory in Randers, Denmark. This will give work to 500 people who have been unemployed. A set of wheels for a freight car before the war cost $40, while now they cost $348.

The Colorado & Southern has awarded a contract to Fairbanks, Morse & Company, Chicago, for the construction of a 300-ton capacity bucket-conveyor type, coaling station at Seventeenth and Champa streets, Denver, Colo. The plant will deliver coal to engines on two tracks and will be operated by a 15-h. p. oil engine.

The American Locomotive Company has begun deliveries of the light Santa Fe type and heavy Mountain type locomotives ordered by the Railroad Administration and deliveries of some of the light Mountain types are expected this month. Deliveries of the heavy Santa Fe and Pacific types are expected to begin in January.

It is stated that the "Pershing" locomotive, built on standardized plans designed by the United States Military Railways, has not only been made the sole type of steam locomotive in use behind the American lines in France and Germany, but, at the instance of the War Industries Board, has been adopted by the British and French Governments as the standard type for their armies on the western front.

The United States Railroad Administration has reinstated the orders for 500 locomotives from the American Locomotive Company and 100 from the Lima Locomotive Works, which had been held up for about a week. Director General McAdoo announced the execution of the contract with the American Locomotive Company on December 4, stating that the contract with the Lima company would be signed in a few days. The announcement stated that these two contracts involve about $40,000,000 and have been awarded on a basis to yield the locomotive builders approximately 6 per cent on cost.

Books, Bulletins, Catalogues, Etc.

Baldwin Record No. 91.

Record No. 91, issued by the Baldwin Locomotive Works, devoted to Mallet Articulated Locomotives, and with 18 illustrations and four letter-press descriptions, forms an elegant pamphlet of 44 pages. A valuable section is devoted to the handling of the Mallet type of locomotive, furnishing details of testing the various valves and other wearing parts. Formulas are also furnished for showing the tractive power of the various designs, which range from the smaller types of about 30,000 lbs. to that of 160,000 lbs. The most of the locomotives described and illustrated are of those in use in American railroads, but there are also samples in use in Japan, Chile and Spain, all of which are interesting as illustrating the adaptability of this type of locomotive to every kind of service. The company has now 27 offices, located in the leading countries of the world, and the company's locomotives have for many years circled the globe.

Packless Valve.

The Gold Car Heating & Lighting Company, 17 Battery Place, New York, has issued a new circular, No. 1140, describing and illustrating a packless valve, designed primarily to be used as an inlet or supply valve in car heating systems, to facilitate the handling of steam heat, especially at terminals where moments are valuable, as a quarter turn opens or closes the valve, and can be opened or closed very quickly. As the valve is packless, the maintenance charge is eliminated. The valve is of the rotary type. The disc is of special composition and is held stationary in its place. The movable disc is of metal and rotates against the fixed composition disc. The contact is positive, and the parts can neither spring, bend or get out of shape. The steam is on top and not against the disc, and the higher the pressure, the tighter the valve. The device could be used in blow-off and other valves. It is a valuable addition to the company's clever devices. Among others of recent introduction are the Packless quick opening twin supply valve, Pope valve, combination gasket tool, pressure regulator, steam hose coupler, gasket, and vapor valve, for application inside the car.

The A B C of Aviation.

The Norman W. Henley Publishing Company, 2 West 45th street, New York, is constantly adding to its stock of books on popular subjects. The work before us is by Captain Victor Page, Sig. R. C. Aviation Sec. an eminent engineer and well-known writer on engineering subjects. The work extends to 400 pages, and contains 130 specially-made illustrations. The book has been written with special reference to the requirements of non-technical men. The style is easily understood, because the elementary principles of flight are considered and fully explained. Specially prepared diagrams fully illustrate the text so that any intelligent reader can readily master the subject. It shows the different parts of an airplane in detail, what they are and what they do. It includes a complete dictionary, and answers every question that anyone can ask about modern aircraft, their construction and operation. Price, $2.50.

Reactions.

The Metal Thermit Corporation, 120 Broadway, New York, in its latest quarterly publication, has several very interesting illustrated articles on railroad operations, notably rail welding under the severest kind of climatic conditions. The lack of material, such as new fish plates and bolts, and the inevitable decay of rails at the joints, has brought the use of thermit into increased demand, and the enterprising corporation are meeting the situation with a degree of promptness that is warmly appreciated. The rail ends are raised and welded and dressed off, and are really better than new. The same may be said of fractured locomotive driving wheel centers, several instances being given by railway men and are published verbatim. A new device is shown for recording the wear on the running surface of rails, with special application to the periodical recording of rail joint wear, which is sure to become popular. Copies of the publication may be had on application.

Small Tools.

The Greenfield Tap and Die Corporation, Greenfield, Mass., has issued Catalogue 40, extending to 288 pages, profusely illustrated. The corporation is an amalgamation of six concerns, with a garnered experience of nearly half a century. It is the condensed expression of the engineering ingenuity of New England directed to one special detail. Its marked success is the best proof of the unquestionable superiority of its products. In the realm of tools, such as dies, screw plates, taps, reamer wrenches, die holders, expansion, shell, chucking and burr reamers, center and countersunk reamers, they are the acme of perfection in material and construction. The miscellaneous section of the catalogue contains a mass of information, particularly in regard to threads, that is of much value. All interested should send for a copy of the catalogue.

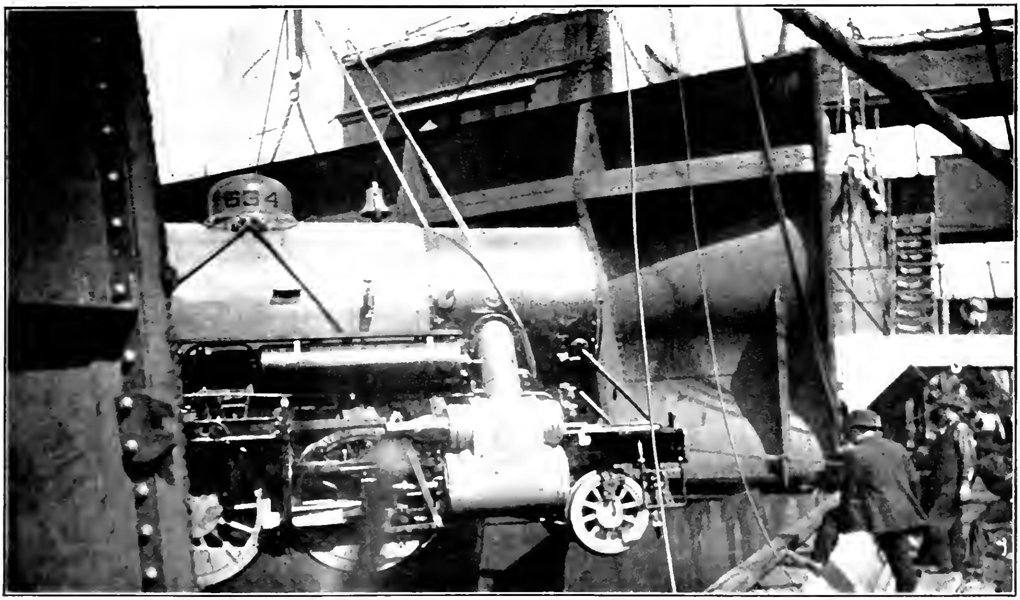
Railway and Locomotive Engineering

A Practical Journal of Motive Power, Rolling Stock and Appliances

Vol. XXXII | 114 Liberty Street, New York, February, 1919 | No. 2

Loading and Transporting Locomotives to France

New Engineering Difficulties Overcome



LOWERING AMERICAN LOCOMOTIVES INTO THE HOLD FOR SHIPMENT TO FRANCE.

Photo Edwin Levick.

The cessation of hostilities in Europe has already given the eyes of intelligent humanity time to look at the record of the appalling struggle and to some extent allow that perspective view out of which comes the salient features that will make up the story of the epical death grapple of the embattled nations, when the historians begin to marshal the facts into concrete history.

The press has been handicapped by a censorship that is hardly intelligible to the common sense of the ordinary reader. The returning soldiers almost unanimously complain of the system imposing silence. It is not vanity that induces the soldier to look for recognition of the accomplishments of the regiment or division to which he is attached. It is a natural and becoming pride having its roots in high ideals and stirred into heroic action by high companionship, and full credit is looked for. Honor may be said to be the highest reward for the true soldier. It induces courageous adventure. It stimulates emulation. To be unnoticed and unknown is dispiriting. That the American people will do full honor to their victorious armies goes without saying, but we need exact and full information so that honor may be given to whom honor is due.

This leads us to observe that there has been little or no mystery in regard to the work of the railroad men. Censorship could not extend its dark curtain over their work. It has been seen and known of all men. The massing of the forces, their conveyance from every nook and corner of our mighty Continent has been an unparalleled exploit in itself. The work of the American railroad men in France has been the theme of universal admiration. All the world has learned a lesson in railroad construction and operation. The nations have sat our feet, and will presently proceed to better means and methods of efficient transportation.

Not only so, but the exigencies of the situation brought out much of the spirit peculiar to American engineering in promptly meeting and overcoming difficulties as they arrive. It will be recalled that at this time last year General Pershing saw the pressing need for American railroad equipment shortly after he arrived in France with the vanguard of the United States Army. One of his first cables showed the urgent demand for locomotives, cars, and rails. Failure to provide adequate systems of transportation might mean the collapse of the entire American effort in France. And so it was that army officials took up the task of buying and shipping locomotives. To load them intact and undismantled was a vision which did not cross the minds of these pioneers. The early locomotives were sent to France "knocked down" in bulky packages, each containing parts of the whole.

In addition to the loss of time erecting these dismantled locomotives after they reached France, it was also necessary for the builders in America to complete all details of the engine before boxing the various parts. In other words, the locomotives had to be set up and tested before they were "knocked down," and this was a loss of valuable time.

Once the parts reached the other side it was a matter of six to ten days for a body of expert engineers to erect a single locomotive. As lifting facilities were limited engineers had to be content with working on one or two engines at a time. The unfortunate results of this are best shown by the number of locomotive ships which, month after month, stood idle at French ports waiting their turn to discharge. When it is considered that only a few steamers are suitable for carrying this cargo, and that at one time, early in 1918, thirteen ships loaded with "knocked down" locomotives were tied up in France waiting discharge, we can gauge the task confronting American shippers.

Early in February, 1918, a cable from General Pershing announced that shipments of locomotives "knocked down" was unsatisfactory, and that effort should be made to send them to France erected and ready for steam. A committee immediately set about to find a vessel suitable for carrying locomotives. Up to October, 1917, no American steamship of a class having hatchways large enough to admit of a locomotive had been constructed. It was soon discovered that the Ore Steamship Company had three vessels which might carry locomotives. The steamships were used in carrying ore from Cuba to Baltimore and were designed with large open holds and hatches. It was in April, 1918, that the first of these ships arrived at Brooklyn. Before the ship arrived at the dock thirty-three locomotives and tenders were on their way from Philadelphia on their own wheels. The orders were to send them in lots of 10, drawn by one locomotive, but railroad engineers, after studying the roadbed decided that at least two bridges between Philadelphia and Jersey City would collapse under the combined weight of the locomotives, in one train. The engines were sent, therefore, at the rate of not more than five a day.

RAISING A LOCOMOTIVE FROM A FLOAT ON THE EAST RIVER, NEW YORK.

The problem of lifting the locomotives from the float into the steamer was solved by the requisitioning of the only floating derrick in New York harbor which was capable of raising 150,500 lbs. in bulk. Once in the hold the locomotive wheels rested on two thicknesses of 3 in. by 12 ins. oak planks. The weight rested on these thicknesses of 3 by 12 ins. oak planks. The weight of the engine imbedded the flanges to their depth, so that the tread of the wheel rested solidly on the plank. Wedges were then placed under the springs to distribute the weight and the brakes were set. Every known precaution was taken to insure the safety of the ship and its cargo, but it was a dangerous experiment at best, and no one was certain of the result. As the loading proceeded the holds took on the appearance of a good-sized railroad yard with polished engines waiting assignment. However, the locomotives were quickly surrounded with bales of compressed hay packed solidly between the boilers and wheels and over the top for five thicknesses. When this floor was level and boarded with planks, the tenders, 55,700 pounds each, were placed on top and blocked in the same manner as the locomotives. This tier was leveled off with more hay and bags of oats.

As an indication of the depth of the hold, the double height of locomotive and tender did not reach the deck of the ship by at least 10 feet, and this space had to be filled with hay, oats, and motor trucks. When the top of the hold had been reached the hatch covers were lowered and tarpaulins placed over them.

On her second voyage the Feltore carried 36 locomotives and tenders, 100 motor trucks and 48 complete airplanes.

The traveler to France in the coming days of peace will find there for the first time new and wonderful railroad equipment built and shipped by Americans. As in war, so also in peace, America will be helping France. And the same efficient locomotives which carried Pershing's army to the world's battleground shortly will be turned to the rehabilitation of the nation were particularly in its means and methods of transportation.

It may be added that in France in less than a half hour when the first iocomtive had been deposited safely on the tracks alongside the dock ready now to move under its own steam, one of the engineers climbed to the top of the boiler and read aloud in broken but eloquent English a chalked message from the locomotive builders of America to the fighters of France:

"Berlin Express! No stop this side of the Rhine!"

Types of United States Standard Cars

Last month we took the earliest opportunity to describe and illustrate a box car built by orders of the United States Railroad Administration, and allotted to

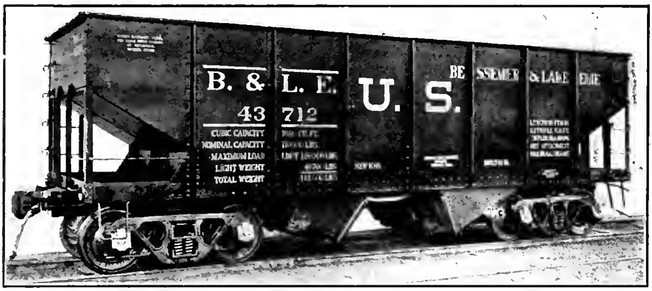
55-TON TYPE OF STEEL HOPPER CAR FOR THE CLEVELAND, CINCINNATI, CHICAGO & ST. LOUIS RAILROAD.

the Chicago & North Western Railroad. During January, 1919, a number of other standard cars have gone into the service of various railroads among other a 55-ton car steel hopper car built by the Pullman Company and allotted to the Cleveland, Cincinnati, Chicago & St. Louis Railroad.

This car, as stated, is an all steel, double hopper bottom gondola, having four doors. The doors are hung crosswise of the car and are operated in pairs. The center still construction is designed to meet the M. C. B. requirements, having an area of not less than 24 sq. ins. in cross section of stress to end load not exceeding .06. All bolts securing steel against steel having cotters, lock washers or lock nuts in addition to common nut, and all bolts for securing wood against wood being riveted on nuts. Draft gear of the piston type, having a minimum capacity of 150,000 lbs. and maximum travel of 2¾ ins. The draw bar yoke is of the vertical plane type and coupler of cast steel in accordance with M. C. B. contour having 6 ins. by 8 ins. Shank, 21¼ ins. long. The coupler operating device is of the top operating type without the use of clevises, links and pins, so as to be directly connected with the locking block.

The general dimensions are as follows: Length inside, 30 ft. 6 ins.; width inside, 9 ft. 5½ ins.; length over striking plate, 31 ft. 11 ins.; width over all (top ladder rung), 10 ft. 3⅜ ins.; height from rail to top of car body, 10 ft. 8 ins.; heigth from rail to top of brake mast, 10 ft. 4½ ins.; distance from center to center of trucks, 21 ft. 11 ins.; height from rail to center of coupler, 2 ft. 10½ ins.; height from rail to bottom of center sill, 2 ft. 4½ ins.; cubic capacity—level full, 1,880 cu. ft.; cubic capacity—with 30 degree heap, 2,235 cu. ft.

The second illustration shows a type of car built by the American Car and Foundry Company and allotted to the Bessemer & Lake Erie Railroad. It is of the best material and built strong throughout. The trucks on which this car rests have a nominal capacity of 100,000 lbs., per pair, and ample strength to carry a load of 121,000 lbs., in addition to the light weight of the body. The truck frames are of cast steel "V" section members with M. C. B. standard removable journal box, or with "V" section members with journal box cast integral, with frames of the arch bar type. Each truck is equipped with M. C. B. extra heavy brake beams, 15,000 lbs. capacity. Car wheels U. S. R. A. standard for cars, having axles with 5½ ins., by 10 ins., journals, Journal bearings of brass, lead lined, with journal bearing wedges of malleable iron, drop forged or cast steel, and of M. C. B. dimensions. The diameter of the wheels is 33 ins. The distance from center to center of journals, 6 ft. 5 ins., and wheel base 5 ft. 6 ins.



TYPE OF CAR ALLOTTED TO THE BESSEMER & LAKE ERIE RAILROAD.

The third illustration shows a composite, high side, flat bottom gondola, with fixed ends and eight flush drop doors. The car is designed to carry a concentrated load of two-thirds of the capacity over a distance of ten feet at the center. As shown the trucks are equipped with helical springs. The pivot pins for M. C.

TYPE OF COMPOSITE, HIGH SIDE, FLAT BOTTOM GONDOLA ALLOTTED TO THE NEW YORK CENTRAL LINES.

B. couplers are heat treated. The piping is welded throughout. The coupling operating device is of the top operating type without the use of clevises, links and pins, that is, directly connected to the locking block. The drop doors are hinged along the center sill to dump towards the side, and operated from side of the car in pairs. Brakes are applied to all wheels, and also arranged to be operated from one end of the car by hand. Braking power about 60 per cent. of light weight of car based on 50 lb. cylinder pressure. Piston travel between 5 and 7 ins. Hand brake power approximately the same as the air brake power. All piping of black steel, standard weight. The draft gear is of the friction type, having minimum capacity of 150,000 lbs., and a maximum travel of 2¾ ins. Cast steel coupler in accordance with M. C. B. contour having 6 by 8 ins. shank, 21¼ ins. long as per standard rules.

The following are the general dimensions of this type of car which has been allotted to the New York Central Lines: Length inside, 41 ft, 6 ins.; width inside 9 ft. 1⅝ ins.; height inside, 4 ft. 8 ins.; length over striking plate, 42 ft., 10½ ins.; width over all, 10 ft., 2⅞ ins.; height from rail to top of car body, 8 ft. 3½ ins.; height from rail to top of brake mast, 7 ft. 11 ins.; distance center to center of trucks, 31 ft., 10½ ins.; height from rail to center of coupler, 2 ft. 10½ ins.; height from rail to bottom of center sill, 2 ft. 4½ ins.; cubic capacity—level full, 1,770 cu. ft.; cubic capacity—with 30 degree heap, 2,230 cu. ft.

Digest of the Report of the Director General of Railroads

Work of the Chief Inspector of Locomotives

The annual report of the Director General of Railroads is particularly interesting as showing the difficulties that have been met and largely overcome during the year in which Federal control has been experimented with, and from which certain general conclusions can safely be drawn in regard to the management of the railroads by the Government. In regard to the general operation of the roads, it is conclusively shown that there is no question of the ability of the railroads to transport to destination all of the freight offering, either domestic or for overseas, provided there are facilities for prompt disposition and unloading at destination.

At the beginning of Federal control the Baldwin Locomotive Works and the American Locomotive Co.'s plants were occupied in the construction of locomotives for the Russian Government, which, on account of the conditions prevailing in that country, it was impossible to deliver. Two hundred of these locomotives were partially constructed and practically all of the material was fabricated. These 200 locomotives were taken over by the War Department and leased to the Railroad Administration and are in service. They were constructed to a 5-foot gauge, as contrasted with our 4-foot 8½-inch regulation. This difference was taken up by the use of wide tires, and these engines have been giving good service and came at a time when the need of additional motive power was very great.

A temporary lease of 135 light consolidation locomotives was made with the War Department. These locomotives were for use in France and were returned and shipped overseas during the months of August and September.

Just prior to the inauguration of Federal control the Railroads' War Board, which had been voluntarily formed by the individual railroads, had transferred to the eastern territory 92 engines from western and 15 engines from southern railroads. In addition, as they came from the manufacturers, 130 new locomotives, which had been constructed for southern, southwestern, northwestern and central western railroads, were placed in service on eastern lines.

In addition to this transfer of power into the eastern region, there was a relocation of power inside of that region from one road to another, amounting to 215 locomotives.

FRANK McMANAMY.

The elimination of nonessential passenger service relieved the situation considerably, but serious conditions resulted from the shortage of efficient motive power, particularly in the eastern section, when Federal control began. The condition of the existing locomotives was also a serious problem, and on February 9, 1918, Mr. Frank McManamy, chief inspector of locomotives for the Interstate Commerce Commission, was appointed manager of the locomotive repair section, and authorized to coordinate the repair of locomotives. He was promoted to assistant director in charge of the mechanical department, including car repairs, supervision of mechanical standards and of tests for new devices. To utilize any of the large manufacturing plants for repairs would very seriously limit their effectiveness in the production of new locomotives, and on account of the competition of high wages paid by the shipbuilding plants and war industries generally, there was a considerable shortage of skilled mechanical workers in railroad shops.

Immediate relief could only be secured by working a greater number of hours. On a large number of railroads there were in existence contracts with the mechanical crafts which limited the number of hours per day. The railway employes' department of the American Federation of Labor, which represented the mechanical crafts on such railroads, very patriotically met this situation and voluntarily agreed that they would, during the period of the war, waive their privileges in this respect. As a result of this, railroad shops on many of the important lines were placed on a basis of 70 hours per week, and the remainder on 60 hours per week, which was approximately an average increase of 20 per cent. in shop hours. In June all shops were placed on the 60-hour-per-week basis, which continued until the signing of the armistice, when arrangements were made for readjusting the hours which were reduced on November 25 to nine, and December 9 to eight hours per day.

A check of the repair shops indicated that their combined capacity was ample to take care of all of the locomotives if they were properly distributed. Plans were immediately perfected to send lo-

comotives to the nearest available repair shop, regardless of ownership and to distribute the work so that each shop could be worked to capacity. This arrangement in many instances actually reduced the distance which defective locomotives were ordinarily sent for repairs and also reduced the time such locomotives were held out of service. Under this plan 2,065 locomotives were transferred to the shops of other railroads under Federal control, where they received heavy classified repairs; otherwise these locomotives could not have been kept in service.

The improvement in the condition of locomotives is perhaps best indicated by the fact that, notwithstanding the tonnage handled during the year has been the heaviest ever known, there are now stored in good condition and ready for winter service, 1,189 locomotives, while one year ago there was not a single serviceable locomotive in storage. This improved condition is due to the coordination of shopwork which has resulted in an average increase of 20.93 per cent. each week in the number of locomotives receiving classified repairs. The general condition of freight cars has also shown a substantial improvement, being a decrease of approximately 43,000 in the number of bad-order cars.

As is well known, the standardization ot locomotives and cars is an ideal which has been striven for by the various organizations of railroad officials, and much has been done by them to bring about this result. Complete accomplishment has never heretofore been possible because of an absence of authority to enforce standards which might be agreed upon. This has now been accomplished by the preparation and adoption of standard designs for different types of locomotives which are suitable for all classes of service and by standardization of freight and passenger equipment. This will increase production by eliminating delay in waiting for designs and patterns and will facilitate repairs and reduce the number of repair parts necessary to be carried in stock. It is interesting to note that one of the large locomotive companies, working solely upon engines of individual design, turned out in a five-week period ending August 17 only 104 completed engines, while the same shop for the five weeks ending October 2 produced 163 engines of standardized design.

It will be remembered that when the Government assumed control an extended period of heavy business, high prices for material, difficulty in obtaining sufficient labor, and the loss of many of their experienced mechanics through the selective draft, followed by an early and unusually severe winter, had resulted in a general defective condition of locomotives and cars which had reached a point where repair tracks were blocked and terminals congested with bad-order cars, and shops and roundhouses were so crowded with locomotives awaiting repairs that proper facilities for maintaining the locomotives actually in service were no longer available.

Prompt handling of locomotives was seriously hampered by the condition of roundhouses and the lack of facilities at many points to make running repairs to large modern locomotives. Roundhouses built 20 or more years ago for locomotives in service at that time were still being used to house locomotives more than twice the size for which they were designed. Repairs had to be made either out of doors or in open roundhouses with the temperature below zero. Steam pipes, injectors, air pumps and even cylinders froze and burst, and in many cases locomotives were actually frozen to the track in roundhouses and could not be moved. In spite of these conditions, under the plan organized by the mechanical department of the Railroad Administration with the assistance of the railroad officials and the cooperation of the employees in working increased hours regardless of working conditions, the situation immediately began to improve and that improvement has continued up to the present time.

The average increase in locomotive-shop hours for the entire country amounted to about 16 per cent., and the effect became immediately apparent by the increased number of locomotives repaired per week in comparison with the most accurate records available for the corresponding week of the preceding year. This increase in shop hours applied to roads where locomotives were in good condition and shop facilities ample, as well as to roads which were not so favorably situated, which enabled a comprehensive program of nationalization of railroad shop facilities over the entire country to be carried out, and locomotives from roads where shop facilities were not sufficient and motive power in bad condition to be sent to shops on other lines for repairs. This distribution of locomotives was so arranged as to reduce, in many instances, distance to the repair shops; therefore, the cost of transporting locomotives to the shops was no greater and all shops under this plan were kept working to their maximum capacity with a full force.

The plan of considering the condition of equipment as a whole and taking steps to improve it by, first, uniformly increasing shop hours on all railroads in the country and utilizing to their full capacity the facilities of all shops which could only be done under Federal control is really what improved the condition of the locomotives and cars and enabled trains to be promptly moved from terminals with reasonable assurance that the locomotives would make a successful trip.

Investigation was also made of the facilities of the different locomotive builders with a view to having locomotives repaired by them, but it was found that this could not be done to any material extent without disarranging their schedule of new work both of domestic and foreign locomotives, and in view of the need for both this was not considered advisable, although both the Baldwin Locomotive Works and the American Locomotive Co. did endeavor to make use of surplus facilities to repair what locomotives they could without interfering with their output of new locomotives.

Illustrative of the improvement in motive power and the changed conditions in railroad shops is the fact that it was possible to grant the request of the Baldwin Locomotive Works, made on September 13, 1918, for assistance in machining locomotive frames, driving boxes, rods and other parts to facilitate the construction of locomotives for the use of our Army in France, and this work was continued in various railroad shops until the armistice was signed.

The increased working hours in railroad shops under the instructions issued on February 14, 1918, were continued until after the signing of the armistice, and without this loyal support from the employes the increased number of locomotives repaired during this period and the assistance rendered locomotive builders would not have been possible. After the signing of the armistice shop hours were reduced to nine per day, effective November 25, and to eight per day, effective December 9, as already stated.

In addition to the vigorous action which had been taken to improve the condition of existing equipment, the necessity of adding to the available stock was recognized and designs were worked out for standardized locomotives and orders placed for their construction.

Specifications were prepared and orders were placed for 1,430 locomotives of standardized types, divided as follows:

Specification 1A, light Mikado	530
Specification 2A, heavy Mikado	217
Specification 3A, light mountain....	35
Specification 4A, heavy mountain...	5
Specification 5A, light Pacific	43
Specification 6A, heavy Pacific	20
Specification 7A, light Santa Fe..	124
Specification 8, heavy Santa Fe.....	50
Specification 9, 6-wheeled switcher.	150

Specification 10, 8-wheeled switcher	150
Specification 11, light mallet........	30
Specification 12, heavy mallet.......	46
Standard consolidation	30
Total...........................	1,430

This order was placed with the American Locomotive Co., Baldwin Locomotive Works and the Lima Locomotive Corporation. The first locomotive was turned out of the Baldwin Locomotive Works on July 4, 1918, and it is expected that this order will be completed so as to have this entire consignment of locomotives in service early in 1919.

The locomotives were built from standardized designs in order to reduce to a minimum the number required to prepare drawings, patterns and dies, and thus enable deliveries to begin quicker than where separate drawings and patterns would have been necessary for each lot of locomotives allocated to a particular road, and also to secure quantity deliveries. The result was that a quantity rate was accomplished which could not have been approached had the locomotives been ordered to individual designs.

The increase in the rate at which standardized locomotives can be turned out is clearly shown by the following comparison of two of the principal shops of the American Locomotive Co. during a portion of July and August when the locomotives built were of individual design with a similar period in September and October when they were building standardized locomotives. During five weeks, beginning July 20, an average of 13 1/5 locomotives per week were turned out at the Dunkirk plant, while during five weeks, beginning September 14, an average of 19 1/5 locomotives per week were turned out at the same plant. For Schenectady, during the five-week period beginning July 20, an average of 8 locomotives per week were turned out, while for the corresponding period beginning September 14, an average of 13 2/5 locomotives were turned out. It will be seen that the increased production due to the standardized locomotives was about 50 per cent.

It has also provided a supply of equipment, the parts of which are largely interchangeable, which is available for use anywhere in the event of congestion. This removes the necessity of carrying a large stock of repair parts particular to the locomotive and avoids delay which results when repair parts must be ordered from some distant owning road.

The freight car situation was handled along the same lines as were the locomotives. After careful consideration, designs were prepared and order placed for the following cars:

25,000 self-clearing, steel hopper cars of 55 tons capacity.

25,000 single sheathed box cars of 50 tons capacity.

25,000 double sheathed box cars of 40 tons capacity.

20,000 composite gondolas, with drop doors, of 50 tons capacity.

5,000 low side gondolas of 70 tons capacity.

In addition to the designs for freight cars, for which orders have been placed, designs have been prepared for all steel box cars of 50 tons capacity, refrigerator cars of 30 tons capacity, general service gondola cars of 50 tons capacity, steel framed stock cars of 40 tons capacity, flat cars of 55 tons capacity, oil tank cars of 7,000 gallons capacity, oil tank cars of 8,000 gallons capacity, oil tank cars of 10,000 gallons capacity, acid tank cars of 7,000 gallons capacity, acid tank cars of 8,000 gallons capacity, and acid tank cars of 10,000 gallons capacity. While no cars have actually been built from these drawings, they are available at any time that the traffic needs show them to be desirable.

Returning to the locomotives, it may be stated that when they are en route to or from other line shops, and new locomotives being delivered by the builders, they were usually hauled dead in trains. Instructions were at once issued that whenever possible such locomotives should be moved under steam, hauling a train wherever practical. In this way the railroads were relieved from 500,000,000-ton miles of transportation annually for material which not only should be self-propelling, but which should, in many instances, be hauling additional freight.

In addition to this extensive investigations were conducted covering shop and engine-house operation, resulting in changes and improvements which have materially increased the output.

For example, at one large shop the output of locomotives receiving classified repairs increased over 50 per cent., and increases ranging from 10 to 25 per cent. were secured in many shops. It was also possible by rearranging the method of handling work in engine-houses to release hundreds of employes that were sorely needed in other departments, and the saving effected in engine-house operation by such reduction in force, while not obtainable for all railroads, on one railroad alone amounted to $1,061,332.68 per annum.

The condition of motive power on all lines under Federal control has shown a gradual improvement, and the locomotives in service are in much better condition than they were one year ago, and on some lines, that last spring required extensive assistance from other line shops, the condition of power has shown such a marked improvement that they are now doing all of their own repair work, and, in addition, are repairing locomotives for other lines.

The designs for standardized locomotives and cars were prepared under the direction of a committee on standards for locomotives and cars, which is composed of representative officials from the mechanical departments of the various railroads. In selecting this committee, consideration was given to conditions existing in all sections of the country, and the men composing the committee were drawn from different sections of the United States. This enabled the committee to intelligently handle the standardization of locomotives and cars so that the needs of all sections would be considered and the equipment designed made suitable for all classes of service. The work of this committee is worthy of special mention and the result of their deliberations represents a long step forward in locomotive and car design. This committee has been continued and meetings are held once in two months for the purpose of considering improvements in design so that the standard equipment will, at all times, represent the most modern practices.

It is also gratifying to learn that on account of the vast number of new devices for use on locomotives and cars which were submitted, a comprehensive plan for handling this question was necessary. Detailed instructions were issued by circular establishing rules for the submission of such devices for the consideration of the Railroad Administration and a committee on appliances was created to conduct necessary investigations and to pass upon the value of all devices or appliances thus submitted. Up to date 692 such devices, which cover practically everything used in locomotive or car construction, have been submitted. One hundred and thirty-five of these have been examined, ten of which have been recommended for test under service conditions. These tests will proceed under the direction of the mechanical department, and a record will be kept of the results, so that the value of the devices in question may be correctly passed upon.

Reports of violations of the laws for the promotion of safety, totaling 682 cases, received from the Interstate Commerce Commission and referred to the mechanical department for correction. Although this work has not been completely organized, the Bureau of Safety and the Bureau of Locomotive Inspection of the Interstate Commerce Commission have advised that substantial improvements in practices have been noted at points where such violations have been handled.

Mallet Locomotives for the Utah Railway

Three Mallet locomotives, as illustrated, have recently been built by The Baldwin Locomotive Works for the Utah Railway. These locomotives are in heavy freight and pushing service on grades of 2.4 per cent; there are curves of 9 degrees on the main line, and of 20 degrees on sidings. The tractive force exerted, working compound, is 96,500 pounds as calculated by the formula

$$T = \frac{C^2 \times S \times 1.7\ P}{(R + 1) \times D}, \text{ in which}$$

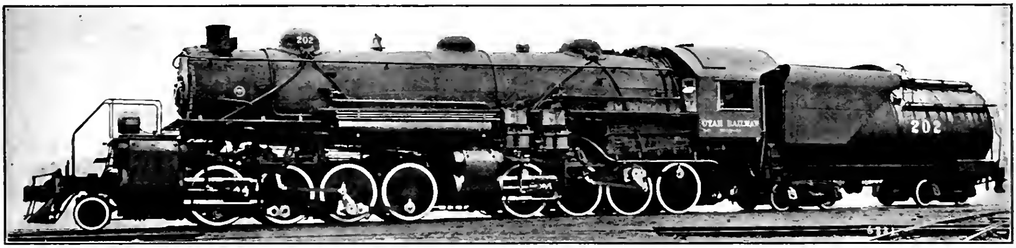
C = diameter of low pressure cylinders (ins.)
S = length of stroke (ins.)
P = boiler pressure (pound per sq. in.)
D = diameter of driving wheels (ins.)
R = ratio of cylinder volumes.

This formula is based on equal work in the high and low pressure cylinders, and on a total mean effective pressure of 85 per cent boiler pressure. It takes account of variable cylinder ratios, and is a safe basis on which to work; and it has been adopted as the official formula of The Baldwin Locomotive Works. In the present case, the ratio of the cylinder volumes is 2.48.

These locomotives have the 2-8-8-0 wheel arrangement, which is well suited to slow speed mountain service. The truck provides an effective guide when running ahead, while 95 per cent of the total weight is carried on the driving wheels. Locomotives of similar type have been in successful operation, for some time, on the Great Northern and Baltimore and Ohio railroads.

The boiler center line is placed 10 ft. 2½ ins. above the rail, and a conical ring in the barrel increases the shell diameter from 90 ins. at the front end to 100 ins. at the throat. The firebox has a combustion chamber 60 ins. long, and the tubes are 24 ft. 0 ins. long. The boiler accessories include a Street type "C" mechanical stoker and a power operated grate shaker. An arch is installed, and is supported on four water tubes. To keep within the clearance limits, the safety valves and whistle are tapped directly into the boiler shell, and the whistle is mounted horizontally. The throttle valve is of the well known Rushton type. In this case, no auxiliary drifting throttle is used, but an automatic vacuum breaker is applied to the cylinders. The locomotive of course uses superheated steam, and the superheater is of large size, with 48 units and 1,446 square feet of surface.

In accordance with the latest practice of the builders, the liners over the high pressure cylinder saddle and waist bearers are placed outside the boiler shell, in order to facilitate caulking. The steam distribution to all four cylinders is controlled by piston valves 15 ins. in diameter. The low pressure valves are double ported. The valve motions are of the Walschaerts type, and are controlled by the Ragonnet power reverse mechanism. The Simplex system of compounding is used on this locomotive. With this system, increased tractive force can be developed by admitting live steam, at reduced pressure, direct to the low pressure cylinders, and discharging the high pressure exhaust up the stack, through an auxiliary pipe connected with the main exhaust nozzle.



J. H. Stevenson, Supt. and M. M. MALLET FOR THE UTAH RAILWAY. Baldwin Locomotive Wks., Builder.

Lubrication is provided by a five-feed lubricator, which is connected to the four cylinders and also to the receiver pipe. A separate two-feed lubricator is used for the air pumps and stoker engine. Flange lubricators are applied to the front and back driving wheels of each group.

The piston heads have a dished section, and are of steel with bronze wearing surfaces. Heat-treated steel is used for the crank pins and driving axles, and the axles and main pins are hollow bored. The frames are of vanadium open-hearth steel, and they are fitted with adjustable pedestal wedges. The Baldwin design of flexible articulated frame connection is used. With this construction, the front and rear frames can move relatively to each other in a vertical plane, without causing binding at the hinge pin. The value of this feature is specially noticeable in a Mallet locomotive with long wheelbase, when passing over uneven tracks or sudden changes in grade.

The tender is of the Vanderbilt type, and is of large size, as it carries 12,000 gallons of water and 20 tons of coal. The fuel space is unusually deep in order to obtain the required capacity, and the side walls curve inward at the top, following the contour of the cab roof. The tender frame is a steel casting in one piece, and the trucks have one-piece side frames of the same material. Attention should be called to the large size of the tender journals, which measure 6½ by 12 ins.

The following are the principal dimensions of this type of locomotive:

Gauge, 4 ft. 8½ ins.; cylinders, 26 ins. and 41 ins. x 32 ins.; valves, piston, 15 ins. diam. Boiler.—Type, conical; diameter, 90 ins.; thickness of sheets, 15/16, in., 1 in., 1 1/16; working pressure, 210 lbs.; fuel, soft coal; staying, radial. Fire Box.—Material, steel; length, 132⅛ ins.; width, 96 ins.; depth, front, 86¾ ins.; depth, back, 69 ins.; thickness of sheets, sides, ⅜ in.; thickness of sheets, back, ⅜ in.; thickness of sheets, crown, ⅜ in.; thickness of sheets, tube, ½ in. Water Space.—Front, 6 ins.; sides, 5 ins.; back, 5 ins. Tubes.—Diameter, 5½ ins. and 2¼ ins.; material, 5½ ins., steel; 2¼ ins., iron; thickness, 5½ ins., 0.150 in.; 2¼ ins., 0.125 in.; number, 5½ ins., 48; 2¼ ins., 269; length, 24 ft. 0 ins. Heating Surface.—Fire box, 231 sq. ft.; combustion chamber, 118 sq. ft.; tubes, 5,443 sq. ft.; firebrick tubes, 43 sq. ft.; total, 5,835 sq. ft.; superheater, 1,446 sq. ft.; grate area, 88.2 sq. ft. Driving Wheels.—Diameter, outside, 57 ins.; diameter, center, 50 ins.; journals, main, 10½ ins. x 20 ins.; journals, others, 10 ins. x 12 ins. Engine Truck Wheels.—Diameter, 30 ins.; journals, 6½ ins. x 14 ins. Wheel Base.—Driving, 41 ft. 2 ins.; rigid, 15 ft. 6 ins.; total engine, 50 ft. 4 ins.; total engine and tender, 88 ft. 6 ins. Weight.—On driving wheels, 452,300 lbs.; on truck, 24,000 lbs.; total engine, 476,300 lbs.; total engine and tender, about 692,000 lbs. Tender.—Wheels, number, 8; wheels, diameter, 33 ins.; journals, 6½ ins. x 12 ins.; tank capacity, 12,000 U. S. gals.; fuel capacity, 20 tons; service, freight.

Details of the Construction of Car Trucks

At a recent meeting of the Canadian Railway Club held in Montreal, L. Brown, supervisor, Angus Car shops, Canadian Pacific Railway, read a paper on "Car Trucks," which was very warmly appreciated by those present, and from which we make condensed extracts. Referring to the weight of trucks, Mr. Brown stated that their weight is approximately one-half that of the body or one-third of the total weight of the car. If the trucks are good, almost any kind of a car has a reasonable chance of reaching the destination safely, but when they are not, the result is usually a train wreck with serious loss. They are located near the ends of the cars so that they will be near the draft gears, and one of the ideals for a draft gear would be for it to pivot directly over the centre of the truck. The farther the draft gear is away from the center of the truck the more strain is placed on the truck laterally and consequently there is more danger of derailment. The trucks in further relation to the car body are as the supports of a bridge are to the superstructure, but they are also required to be capable of moving forwards and backwards, rotate horizontally under the superstructure, adjust themselves to uneven tracks and withstand severe strains from heavy loads, high speeds and sudden stops.

In regard to the truck wheels, the larger the diameter of the wheel the less revolutions there are at the journals and the better the bearings on and against the track rail. The materials of which wheels are usually made are cast iron for freight cars and steel for passenger cars. Cast iron wheels are much cheaper than steel wheels and give excellent service under heavy loads running at moderate speeds, but they have not the tenacity to withstand shocks like those made of steel. The treads of cast iron wheels are chilled while in the molten state of casting, which gives them a harder wearing surface than the best steel has. The hubs are soft like ordinary cast iron and can be easily bored to fit the axles. Steel wheels are usually made by being forged, but some are cast. Some makers of light cast wheels endeavor to get a hard wearing tread as in the cast iron wheels by mixing manganese in the molten steel in such a way that it will appear in the tread but not at the hub. The forged wheels are made with thicker treads so that they can have their wearing surfaces renewed repeatedly, and this to a considerable extent offsets their larger cost when new. Tires which can be replaced by other tires after they are worn out are largely used on steel centres, and in some cases on cast iron centres. The usual method of securing tires is to bore them about one-thousandth smaller in diameter than the outside of the centres and then by heating so expand them that they will fit over the centres and tighten on them as they cool. If the tire is shrunk on much tighter than mentioned the steel is too much strained and is liable to break or the tire becomes loose in service.

The wheels are mounted on the axles by hydraulic pressure of approximately ten tons for each inch of wheel seat diameter, thus making them rotate with the axles, which is very different from the method used on small vehicles, where the wheels usually rotate on axles which are fixed. The distance apart at which wheels may be mounted on axles is limited to a total variation of one-eighth of an inch, which makes it necessary for very careful work to be done, not only when mounting but also when making flanges, boring hubs and aligning axles.

A wheel wearing hollow will cause the flange of the opposite wheel to continually wear itself away against the inner edge of the track rail. A wheel with a sharp flange is dangerous because of the greater liability for the flange to break off and also to mount the rail and cause a derailment. Sharp flanges are principally caused by wheels of unequal diameter being mounted on the same axle. The treads of the wheels are coned and the larger wheel in finding a diameter equal to the smaller wheel tracks nearer the outer rim thus forcing the smaller wheel to track nearer the flange. Curvature of tracks also has considerable effect in causing sharp flanges. The wheels on one side of a six-wheel truck are frequently forced three-fourths of an inch out of line with each other by the curvature of the track rails. A great saving of material in steel wheels can be made by taking those with worn flanges out of service before they reach the limits allowed by the Master Car Builder's wheel defect gauge. Steel wheels are frequently found on which the flanges are so much worn that three-fourths of an inch of metal has to be turned off the tire thickness in order to restore the tread and flange to the standard shape, while the opposite wheel on the same axle, which generally wears hollow, does not require more than one-fourth of an inch to be turned off. When we consider that one-eighth of an inch of tire thickness is worth a day's wages it is well worth while to inspect wheels closely under cars at home terminals for evidences of worn flanges. The Master Car Builder's wheel defect gauge is the only gauge in regular use for detecting worn flanges, but it was primarily intended for limiting the wear on cast iron wheels which cannot be re-turned, and it is unsuitable for gauging the flange thickness on wheels which can be re-turned, because it allows such wheels to get in the condition before mentioned. A very suitable gauge for limiting the flange wear of wheels which can be re-turned is the Master Car Builder's flange limit gauge for remounting cast iron wheels for cars of eighty thousand pounds capacity and over. When the bottom inside corner of this gauge (which is nearest the throat of the wheel flange) rests on the wheel tread, the flange is usually so worn that seldom more than three-eights of an inch is required to be turned off to restore the standard shape. The use of this gauge will save further waste of good material and frequently prevent the necessity for remating wheels. A similar advantage, but somewhat less could be obtained by limiting the worn vertical height of flanges to ⅞ in. instead of 1 in. so wheels can be re-turned.

The whole load of the car is distributed on the axle journals which are located outside the wheels. Axles are also becoming universally used as a source of power to generate electricity for lighting passenger cars. The revolving axle is harnessed to drive a dynamo which is frequently supported by the truck frame. The causes of hot boxes are numerous, but the troubles may generally be attributed to lack of proper movement of the parts in relation to each other or to lack of proper lubrication. When inspecting journals it is well to see that they have freedom to move in pedestals, that covers fit well and are tight, that dust guards fit well around the wheel seat and inside the box, but have freedom to move in the box, that journal collars are not too large or too small, and that they have no sharp or rough edges to catch or tear the packing, that journals are perfectly smooth and that there is some clearance between the collar and the end of the bearing or between the side lugs of the bearing and the stops for the same inside the box, that the bearing is central on the journal, that the wedge is resting on the bearing in proper relation to it and to the box, and that clearance is provided for the wedge to rock on its rounded surface under the top of the box, and that the packing is of good quality free from grit, well oiled, and well packed in the bottom of the box to a height half way up the journal.

The journal bearings are made of brass because it is much softer than steel and therefore will not get hot so readily from the friction created in service; but brass is costly and it is lined with a cheaper and

softer metal known as "babbitt," which is composed of lead and other ingredients which give it the required hardness for wear and yet render it soft enough to adjust itself to the varying diameter of journals. Bearings on which the linings have become worn can easily be relined by melting off the old lining, retinning the connecting surfaces where necessary and recasting the old babbitt metal as a new lining. It is not to be expected, however, that the new lining will adhere to an old bearing as well as to a new bearing on account of the oil which has saturated the brass, therefore, when melting the babbitt, the bearing should not be made so hot that the tinning will be burnt off, and the oil on top of the molten babbitt should all be skimmed off before any metal is taken out of the caldron to be recast. Grooves on each side of the inside of the bearing are good to form keyways for the lining so that it cannot move out of place should it become loose, but this is not provided for in the M. C. B. standard designs. Some railroads re-bore the old brass thus providing a surface practically as good as on new brass.

Journal bearing wedges or keys are made of steel, either cast or drop forged, and others are made of malleable iron. Wedges partially hollow on the tops came into use a few years ago but have since been condemned on account of the ribs bedding into the tops of the boxes and thus doing away with the usefulness of the camber on the wedge, which is designed to eliminate the strains caused where the two track rails are not of equal height in relation to each other.

Journal box packing should act like a lamp wick so that it will keep the oil continually in contact with the journal. In order to do this the packing should not only be in sufficient quantity to reach the journal but it should have the quality of permanent springiness, as packing which sags soon loses contact with the journal. It is for this reason that wool waste is better than cotton. Packing which has been in service gets clogged and lumpy and contains dirt, cinders and metal which not only interferes with the process of lubrication but injures the journal. Such packing should be removed and renovated when cars are undergoing repairs. The renovating process is done by heating the packing so that it will loosen and allow the solid matter to fall apart.

Dust guards should be capable of keeping dirt and cinders from entering the back of the journal box at all times. They should fit close to the axle but without injuring it. The height and width should be such that they will have as much freedom to move in the slots in the boxes as the axles have, but the thickness of the guard should almost fill the slot. The method of closing up the top of the dust guard slot in the box with a piece of tapered wood seems to leave something desired, as the blocks are frequently missing.

The helical springs are generally made of round steel bars turned into coils of a uniform diameter rising one above the other. The strength of these springs increases as the thickness of the steel increases, and as the diameter decreases. The adding of coil upon coil simply gives the spring so much more movement and does not increase its strength to carry a load. These springs simply distribute the shocks and do not absorb any of them. Elliptic springs are made of flat steel plates put together in layers and arched. The strength of these springs increases as the thickness and number of the plates increases and as their length decreases. Elliptic springs are no stronger than semi-elliptic springs and the additional half of the spring simply gives so much more movement and absorbs twice as much shock by the friction between the additional plates.

The centre bearing is where the car body rests on the truck bolster. This is located at the centre of the truck and is so made that it forms a pivot between the car body and the truck. A pin through the centre keeps the bearing plate on the car body from getting away from the truck plate. Some centre pins are so designed that they will hold the trucks to the body when the car is derailed Centre plates require lubricating occasionally, which is generally done when cars are being repaired. In order to keep the lubricating oil in place and to form a bearing for the centre pin a wall around the pin hole in the truck plate is a desirable feature.

Side bearings are required to prevent the car from tilting sideways and as they are located near each side of the truck they are formed to correspond with the radius from the centre. It is not desirable for the car to rest on the side bearings all the time as it does on the centre bearings. In fact, it is the general practice to try to maintain an average clearance of from one-eighth inch to one-quarter inch at each side bearing. If a car is resting hard on its side bearings it is more liable to turn the trucks off the tracks. A side bearing should always be ready to receive the load of the car body temporarily whether on straight tracks or curved tracks and to move under it with as little friction as possible and to allow the load to release itself as soon as necessary There are many designs of side bearings on the market, some of which are very complicated and expensive. It is desirable that they should be simple in construction and have as few parts as possible. Complicated bearings, which are usually designed to be anti-friction, are very liable to get out of order and their parts get lost and are difficult to replace. The old style of flat bearings with an oil well in the centre of the bottom part gives the least trouble to maintain and probably averages greater efficiency than the more complicated roller bearings.

The modern truck is made almost entirely of steel and of course has greater strength and staying qualities than those which were formerly made partially of wood, but it has not that extent of resiliency and feeling of easy riding which is a feature in favor of the wood frame trucks. In order to provide the easy riding qualities of steel passenger trucks resort is made to cushions of softer material, such as wood or rubber, and these are usually inserted under the centre plates and over the springs.

Clearances under all circumstances and at all times are a necessary requirement and provision for easy adjustment to compensate for wear and movement should be made in the design. Vertical clearances should be provided for springs and bolsters to be free when new and without any load, and for all the moving parts to be free under load when tires, journals, bearings, pins and springs are at their smallest limits. Horizontal clearances should be provided so that trucks can rotate horizontally on all railroad track curves. An approximate figure for horizontal clearances for passenger car trucks and one easy to remember is one inch for each foot distant from the centre pin. Clearances of parts above the top of track rails should be ample so that when wheels and other parts are worn down to their smallest limits there will be no danger of anything striking the track. Some track switch parts project two and one-half inches above the rails and all truck parts, with the exception of wheels, should always be kept well above that figure.

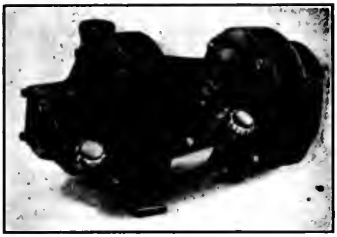
Friction between moving parts requires some consideration. Steel against steel soon wears away and steel against iron is little better. Steel against cast iron is somewhat better, but cast iron against chilled cast iron gives still better results. These effects may be noted between journal boxes and pedestals, columns and bolsters, and upper and lower centre plates.

Trucks and their parts should, as much as possible, be kept to one standard for each kind in order to facilitate interchangeability and expedite repairs. One class of truck can be used under various classes of cars but what is standard for one railroad is too often not standard for other railroads and cars are frequently kept out of service for months waiting for unusual material to effect repairs. The Master Car Builder's standards should always be followed unless there is a very good reason to do otherwise, and all railroads should take an interest in helping that association to adopt the best practices that ingenuity can devise and approach towards perfection.

Electric Headlights on Steam Locomotives

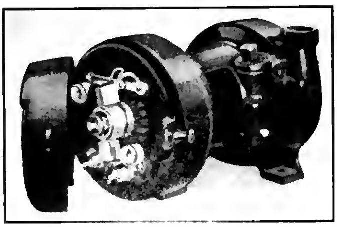
Construction and Maintenance of "K-2" and "K" Headlight Equipments

Although the introduction of the electric headlight on locomotives met with considerable opposition, it is gratifying to observe that its adoption is proceeding with a degree of rapidity equal to the output of the manufacturers. Not only so, but the absorbing question of a need of economy in fuel consumption has called into action the brightest minds in the electrical engineering world to produce the required illuminating power at the least possible expense. Hence those who may be familiar with the details of the earlier products should take the opportunity to familiarize themselves with the improved electric headlights that are now being placed in service to the end that the best possible results that a proper installation and maintenance of the appliance may be obtained.



"K-2" TURBO-GENERATOR.

The Pyle-National Type "K-2" and Turbo-Generators and Headlights embody the most recent developments in the design and construction of electric incandescent headlights for steam locomotives. The equipments are suitable both for switching locomotives and for locomotives in road service on which an incandescent headlight is desired. The capacity of the "K-2" turbo-generator is 500 watts, and the normal capacity of the "K" 350 watts, which is not only ample to illuminate the headlight and cab, but also the classification, number indicator, deck and marker lights.



"K-2" DYNAMO.

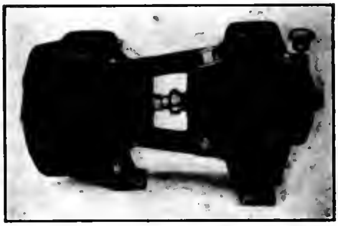
The speed and the voltage control are combined in a positive regulating mechanism of the centrifugal type, which also compensates for variation in boiler pressure between 125 and 250 lbs., saturated or superheated steam. An important and economic feature of the regulating mechanism is to conserve steam. In yards and stations where the full capacity of the turbo-generator is not required, where possibly the cab lights only are necessary, or where the total requirement is below the capacity, as in switching locomotives, only sufficient steam to perform the actual work is admitted to the turbine nozzle.

The steam is conveyed to the turbine by a ⅜-in. pipe. A strainer, easily cleaned, effectively prevents scale or dirt from obstructing the nozzle. Exhaust steam is disposed of through a 1½-in. pipe, which should be as short as is consistent.

As shown in the accompanying illustrations the compactness of "K-2" and "K" turbo-generators, together with their capacity and efficiency, makes them most admirably suited for any electrical purpose within their rating. They can be furnished to any voltage from 32 to 110 inclusive. In regard to the bearings, the armature end of the shaft, together with its rotating parts, are supported by a heavy ball-bearing mounted in a suitable dirt-proof oil cellar of large capacity between the turbine and generator housings, and is supplied with lubricant through a large oil cup. The turbine end of the "K-2" shaft is supported by a self-aligning ball-bearing mounted in an oil chamber integral with the turbine cover, but insulated therefrom by an air space which reduces radiation of heat, assuring a low temperature to the lubricating oil. The cellar is effectually sealed against admission of dirt or moisture and escape of oil. An additional packing prevents the escape of steam from the turbine to the air space between the cover and oil chamber. Oil is fed directly to the bearing by an oil ring. A dam is provided allowing the oil chamber cover to be removed without spilling the oil. The turbine cover with all parts may be removed by the removal of the screws holding the cover in place.

The turbine end of the "K" shaft is supported by a bronze sleeve bearing of special design. This bearing is amply supplied with lubricant by an oil ring feed from an oil chamber. This chamber is provided with an overflow which automatically drains off all water of condensation and maintains a constant oil level. The oil cellars of both bearings are replenished through large oil cups, conveniently located.

In regard to the dynamo, the standard winding of which is for 32 volts, it is of the bi-polar Lundell type. The armature and commutator are integral and are mounted on the turbine shaft and securely locked in place by a single cap screw, the brush holders having a fixed position. It



"K" TURBO-GENERATOR.

may be added that by reason of the very low voltage there is no danger of injury to the person from electrical shock.

The armature is of the ring wound type. The case is built of laminations mounted upon a brass spider, which also forms the core of the commutator, and is of liberal proportions. The windings are large with fireproof insulation. The armature is held on the shaft by a key washer which fits into a slot in the end of the shaft and a corresponding slot in the armature sleeve, facilitating removal and replacement.

The casing of the headlight is made from rolled steel and malleable iron, reinforced by heavy steel bands, all seams and joints being electrically welded. Slotted holes in the base admit of adjustment for the purpose of training the light on the track after the case has been mounted on the locomotive. Holes are also provided

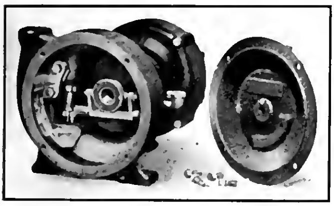
"K" DYNAMO.

in the back of the case for the lead wires which attach to the terminal of the automatic. The goggle, or front door, is hinged on both sides, making the interior of he case easy of access from either side of the locomotive for the purpose of removing

the reflector slide or to clean the reflector. The hinged member frames permit of easy access for focussing. The lamp is focussed in the reflector by means of a "micrometer" focussing device, the purpose of which is to accomplish a free movement of the lamp bulb in any direction, and with no interference, one movement with another. Lock nuts secure the adjustment. The reflector is made from heavy gauge copper spun true to a parabolic curve, heavy silver plated and finely polished. The electrical connections are automatically made by blade contacts when the reflector and slide are in place. It is not necessary to disconnect wires when removing the reflector from the case.

In the matter of illuminating power, a 250-watt lamp properly focussed in the standard reflector under normal conditions lights the track sufficient for all headlighting purposes for distances of from 1,000 to 1,500 feet. A 60 or 100-watt lamp, in either the 14-in. or 18-in. reflector, is ample to meet switching locomotive service conditions.

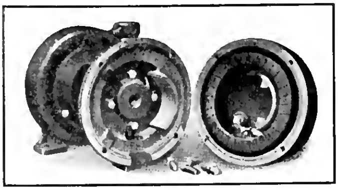
Regarding the proper installation, the



TYPE "K" TURBO-GENERATOR TURBINE —INTERIOR.

turbo-generator should be located on the top of the boiler forward of the whistle dome, but as near as possible to the source of steam supply. If it should be necessary to locate the turbo-generator back of the whistle or safety valves, a protector plate should be provided for protecting the turbo-generator against escaping steam from the safety valves and whistle. In attaching the turbo-generator to the boiler ¾-in. studs are used in fastening the appliance. Care should be taken to see that the dynamo door and turbine cover are not fouled by whistle rods and pipes. Diagrams for the usual methods of wiring will be furnished by the manufacturers; in special cases, blue prints will be furnished. A switch is furnished for turning off the headlight and should be placed on the right side of the cab, convenient to the engineer.

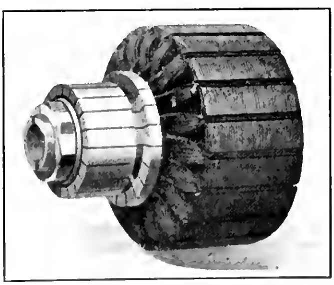
In regard to the maintenance of the electric headlight appliances, we cannot do better than quote verbatim an instructive article from the pen of Crawford McGinnis, an electrical engineer of marked experience and ability, and special representative of the Pyle-National Company. His observations have been of the widest and his terse instructions are of real value to all who are desirous of obtaining the best results from the use of the electric headlight. Mr. McGinnis states that a leading scientific magazine recently published, as a news item, the information that a large railroad had just purchased 500 electric headlight equipments. It further stated



TYPE "K-2," SHOWING INTERIOR OF DYNAMO.

that if electricity proved to be successful as a locomotive headlight, this railroad might later on decide to replace all of their oil headlights with electricity. Again, the writer was asked, some two weeks ago, by the general foreman of one of the large eastern railway shops if in his (the writer's) opinion the electric headlight would ever be as dependable as the oil headlight.

The foregoing are but two of the several indications that there has not been devoted to the subject of electric headlights for steam locomotives that amount of space times printer's ink which the subject and the reading railroad man deserves. Electric headlights had been in use in this country some 20 years and there were possibly 32,000 in operation in North America at the time the scientific news item was published. Also, there are roads operating with no more than one headlight failure each 500 engine months. Correct design and a high degree of turbo-generator development are to no small de-

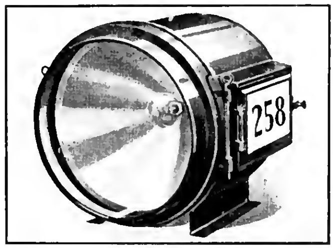


"K-2" AND "K" ARMATURE.

gree responsible for such records, but proper installation and maintenance play a large and important part in successful electric headlight operation.

The reader of RAILWAY AND LOCOMOTIVE ENGINEERING may not be deeply concerned as to how to dissipate gyroscopic reaction in headlight turbines, nor as to the relative coefficients of the various metals employed. Neither does he care greatly how field compounding is proportioned, but he may come to some valuable conclusions after reading the manufacturer's suggestions bearing on the manner in which an installation is applied or the care it should receive. Therefore, if these following brief suggestions indicate the way out of some headlight difficulty, score another for printer's ink.

Mounting the turbo-generator lengthwise of the boiler is preferable to crosswise, making it more accessible for oiling, etc. The shorter the steam pipe to the turbine the less trouble from rust, scale and condensation. A pair of boiler brackets are better than a plate for a machine base; there is not the opportunity for cinders to collect. It is better to drain the steam line back into the boiler or into the turbine than to have a pocket and a separate steam pipe drain. Put no valve of any kind into the turbine drain pipe and



PYLE-NATIONAL STANDARD INCANDESCENT HEADLIGHT CASE.

don't terminate the pipe in the ash-pan, but rather against some heated surface of the locomotive. It should be as nearly a vertical drop as possible. A "tee" in the steam pipe, where it enters the turbine, makes a place for the occasional introduction of kerosene or black oil into the steam parts of the turbine. There are no better agents for cutting loose the scaly deposits which often accumulate. The exhaust opening at the top of the turbine wheel chamber will vent the steam from a frozen turbine and prevent bursting.

Oil is preferable to grease for turbo-generator bearings, because oil is generally cleaner than grease, and possible grit will settle to the bottom of an oil cellar and out of the way. Also, because most any oil, when clean engine oil is not more convenient, will keep a ball bearing out of trouble, while rod-cup and driving box grease positively will not lubricate a ball-bearing.

Drain from the turbine oil cellar occasionally any moisture which may have collected. Before replacing any parts of turbo-generator cap, coat well with graphite and oil. When using the headlight open the steam valve in the cab at least

two whole turns. If the cab lamps are brighter than normal, report conditions to the proper persons.

A turbo-generator is not properly installed if not well tightened down to its base and lock-washered. If headlight burns dim, remove brass cap on top of turbine and blow out scale. Keep the armature tight on the shaft and the wires tight on the binding posts. The hand-rail makes a good wire conduit only when the standards are so arranged that the hand-rail can be lifted off the boiler instead of driven off.

When "black spots" occur in the light thrown by the headlight the lamp is out of focus. Nothing else will cause spots. Move the lamp by means of the focussing device until the dark patches on the track disappear. The headlight beam can never be "focussed" on the track unless the headlight cage or house is "straight" on the boiler. Never put the classification lamp switch in the cab or anywhere else except at the classification lamp. A little work now and then around a headlight equipment will do more toward keeping the headlight in good shape than numberless inspections.

Peat in Great Britain and Canada

Scarcity of coal in Great Britain, due to the absence of miners at the front, has raised the question of coal substitutes, and peat is mentioned as a suitable alternative for low-grade fuels. Peat deposits in England, Scotland and Wales have remained almost untouched because of the low price of coal, but war conditions, necessitating, as they have, the restriction of coal supplies, bring the possible utilization of peat to the fore.

According to the estimates of engineers who have studied the matter, available low-grade fuel in the form of peat is greater than all the world's sources of coal. In the United Kingdom the peat area is estimated at 9,400 square miles, while that of Canada is 37,000 square miles, of an average depth of 6 feet. Of this vast area, 12,000 square miles are located in the central Provinces and represent the heating equivalent of 5,000,000,000 tons of anthracite.

It is reported that the Canadian Government has directed its attention to the development of peat, and its Department of Mines has, within the last 10 years, mapped out 58 Canadian peat bogs conveniently situated.

Paint Like Enamel

To make white paint look like enamel, take a piece of caustic soda the size of a marble and dissolve thoroughly in half a wineglassful of spirits of turpentine, and add this to a 2-lb. tin of white zinc paint; stir well, and it is ready for use. When dry, it will be found to have a glossy surface which almost equals enamel.

Locomotive Steam Pipe Water Trap

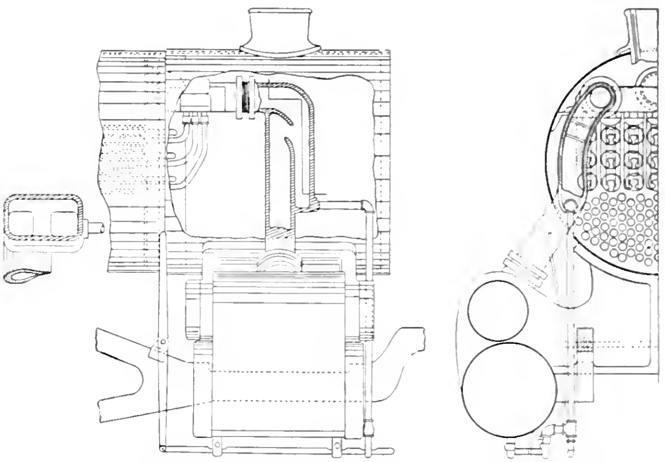
By J. SNOWDEN BELL

Locomotive cylinder failures, resulting from accumulation of water in the cylinders, have lately become comparatively frequent, and the resultant losses are so serious that any preventive measures which seem to offer reasonable prospects of success should receive the attention of those in charge of motive power. The construction here illustrated, which is that of Mr. R. C. Morton, of the Machinery Department of the Baltimore & Ohio R. R., is designed to prevent breakage of locomotive cylinders by reason of the presence of water, and appears to be capable of accomplishing that purpose.

It is a well known fact that, in the operation of locomotives, it frequently occurs that enginemen will carry water at too high a level in the boiler, with the result that a considerable quantity is worked through the engine cylinders and the lubrication thereof is flooded out. Again, it is often the case, when locomotives are standing some little time in roundhouses or yards, that, by reason of leakage past the throttle valve, steam passes into the cylinders, and the resultant accumulated condensate causes their breakage when the locomotive is moved, thereby involving considerable expense for repair, and the loss of service of the locomotive while repairs are being made. These seriously objectionable results, which are familiar to those in charge of locomotive operation, will, it is thought, be eliminated by the application of the Morton appliance.

The construction, which is very simple, and will be readily understood from the illustrations, consists of a steam pipe having a water receptacle or trap extending along one of its sides for the greater part of its length, this receptacle having a drain pipe leading from its lower end to a point below the adjoining cylinder, the outlet of the drain pipe being closed by an automatic drain valve. The drain pipe also has a discharge cock which is opened and closed by a connection to the cylinder cock rigging. The current of steam is deflected away from the water receptacle by a curved plate, and water that may be carried with the steam, falls, by gravity, into the water receptacle, from which it is discharged by the cocks referred to.

It will be seen that the cost of construction and maintenance of the appliance is inconsiderable; that it involves no perceptible obstruction of the volume of the smoke box, and that it is applicable in connection with either outside or inside steam pipes, without interference with, or modification of, other members contained in the front end of the locomotive. The practical value and importance of the capacity which it affords of preventing accumulation of water in the cylinders will be readily recognized by those who have experienced the detrimental results of such accumulation.



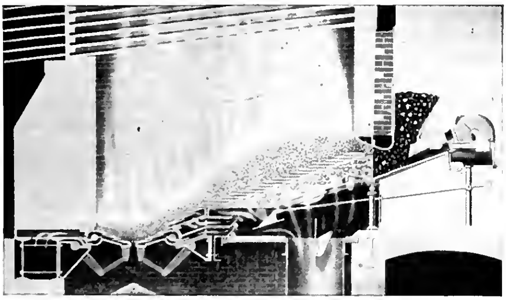
VIEW OF DETAILS OF THE MORTON STEAM PIPE WATER TRAP.

Bell Metal

The best bell metal is composed of 78 parts of copper and 22 of tin. The use of silver in the manufacture of bells is purely imaginary. The idea grew out of a practice at the casting of church-bells when pieces of silver were supposed to be mixed with the bell metal. The foundrymen had other uses for the pieces of silver and contrived means for the silver pieces to fall through the grate bars into the ashpit. Nearly all bell makers have their own methods for determining the tone of a bell from a certain size.

Distinguishing Features of the Westinghouse Underfeed Stoker

Just at the time when power plants are particularly interested in coal saving suggestions and are utilizing every available means for fuel economy, a knowledge of the efficiency of the Westinghouse Underfeed Stoker is timely. The economical advantage derived from an underfeed stoker is briefly this: labor use in hand firing is released to other sections of the works, responsibility for the power plant is centralized, as one man can attend to many stokers, plants required to carry high peak loads of certain periods of the day do not need to maintain extra boilers, and, greatest of all,—one-quarter as much coal is required if the stokers are intelligently operated. The coal saving is a result of smokeless combustion due to heating the volatile substances in the coal before introducing them to the fuel bed, and to correct mixing of air with the coal.



DETAILS OF THE WESTINGHOUSE UNDERFEED STOKER.

LOWER VIEW OF TUYERES.

The principle of design for the Westinghouse Underfeed Stoker, although of the general type of inclined multiple-retort, has many distinguishing features. There are three divisions of the parts of the furnace, the fuel feeding, the fuel burning and the refuse disposal, which will be separately considered in the following discussion.

In regard to the fuel feeding, as shown in the illustration, the hopper is constructed practically the full width of the furnace, and of such size as to provide a large storage of coal. The construction is of heavy steel front plates properly strengthened with heavy cast-iron ends to provide against warping. The width of the hopper provides for a complete supply of coal to the sides of the furnace.

The usual Westinghouse qualities, such as strength, ruggedness, reliability, and ability to withstand severe service, have been incorporated into the construction of the Westinghouse Underfeed fuel feeding mechanism. This consists of a machine or ram, operating in an inclined machine cylinder forming part of the ram box. This construction also provides, by proper design, against sifting of fine coal.

The plungers, or rams, are connected to heavy designed crank shafts of cast steel made up in unit sections and connected together with fitted bolts. All shafts are carefully inspected and gauged before assembly in the shop.

The bearing brackets for the crank shafts are of rugged construction, heavily ribbed and so designed as to provide a large factor of safety. They are bolted to the ram boxes and, in this way, tie them together. All bearings are babbitted and provided with grease cups for lubrication.

Reduction worm gearing is used to drive the crank shaft. The main power worm gear is connected by fitted bolts to the flanges of the crank shaft, and is driven by a worm mounted on a cross shaft supported in the gear box. This shaft, in turn, is driven by a bronze worm gear and hardened steel worm fitted to the speed shaft. One gear set is used to drive a maximum of four retorts. Long life is secured by enclosing the gearing and operating it in a bath of graphite and oil. A large hinged cover on the gear case makes inspection easy.

The lower ram is operated by means of connecting rods, through lost-motion mechanism, to the upper ram, thus eliminating all links and levers. It reciprocates along the bottom of the retort, and in the same plane as the main ram. All contact parts are machined and provided with sufficient clearance to overcome any binding due to expansion of contraction of the metal, and have long overlapping machined surfaces which prevent any sifting of coal to the wind box.

In regard to fuel burning and disposal it may be noted that above the upper end of the tuyere boxes, and extending laterally across the furnace, are air distributing boxes which are bolted to the ram boxes. These are made of unit retort width, cast hollow, and designed to transmit part of the load of the front wall to the tuyere boxes.

A fuel deflecting plate is provided in the retort for varying the thickness and outline of the fuel bed. After being set for the kind of fuel used, no further adjustment is required.

Westinghouse furnace observation doors are specially designed to withstand high furnace temperatures. The door frames are set entirely outside of the brickwork. Standard fire-brick is used for door linings, thus eliminating the necessity of using special-shaped brick.

The forward and rear dumping grates are made up of frames to which are fitted interchangeable corrugated grate bar tops, and, in this way, a passage for air is formed. These are made of the unit retort width, the lower grate bar top being bolted so as to lock the other tops in place. The forward dumping grate is pivotally connected to the dump grate brackets, and projects towards the bridge-wall, and the rear dumping grate is supported in a similar manner and projects toward the front of the stoker. Both dump grates are operated from the side of the furnace.

Bolted to the channels which support the lower end of the tuyere boxes are dump grate shaft brackets which form a support for the overfeed grate and the forward dumping grate. The overfeed grate is of unit retort width and is operated by the upper ram through suitable rods and lost-motion connection.

The rods return the overfeed grate to the same position on each stoker. The travel forward is adjusted by changing the amount of lost-motion by means of collars. These are easily placed on the rods from the front of the stoker. Any chance of damage to stoker parts by mis-

placement of these collars is provided against by machining the rods to fit the collars only where they are attached.

The furnace is sealed, from the stoker front to the rear of tuyere boxes, by means of reinforced concrete floor. Dampers are provided and set in the floor to control the air from the main air ducts. Auxiliary dampers divide the wind box transversely. Doors are placed in the front for access to the wind box and for air admission when the stokers are being operated on natural draft.

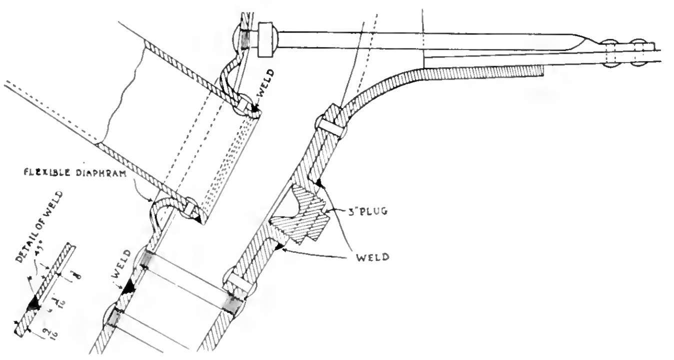
The tuyere boxes used are of the box girder type. The upper surfaces are machined for proper fitting of the tuyeres. Their front ends are bolted to the ram boxes and rest on angles properly supported from the floor. Their rear ends are tied together. The ribs, as shown on the sides of the tuyere boxes, are used for supporting the retort bottoms.

The tuyeres are of distinctive construction. The metal is uniform in thickness, providing for expansion and contraction without cracking. The tuyeres hook into recesses in the top of the tuyere boxes and interlock into each other, thus rigidly holding them in place. As shown in the cut, the tuyeres are laid, one upon the other, and the entire block is locked in by means of the upper tuyere.

Further Details of the Nicholson Thermic Syphon.

In addition to the details of the article that we published last month in regard to the test of locomotives on the Chicago, Milwaukee & St. Paul Railway, equipped with the Nicholson Thermic Syphon, it is of added interest to note by the accompanying drawing an improved method of securing syphons to the throat sheet. As shown, a separate diaphragm plate to which the syphon is secured by riveting and welding, and the plate itself is welded into the throat sheet and stayed in the manner shown. This not only gives flexibility to take care of the contraction and expansion, but also makes a much more simple manufacturing job and enables the manufacturers to practically standardize the syphon itself to such an extent that one or two forms and dies will cover all the different designs of syphons.

By referring to the previous article alluded to it will be noted that the syphon is of a double structure, considerably increasing the heating surface, and compelling a rapid circulation of the water in the spaces adjoining the hottest parts of the firebox, which, of course, naturally accounts for the marked economy of fuel as shown in the tables of tests accompanying the original article.



METHOD OF SECURING SYPHON TO THE THROAT SHEET.

Railways and the U. S. Forces.

The British Controller of Shipping, Sir Joseph Maclay, in referring to the movement of the American Expeditionary Forces across the sea as "a transport miracle," says that most people have been inclined to attribute this achievement solely to our navy and shipping, but he speaks in high praise of the share the American railroads had in the work. He says: "If the American railroads had not been operated with success the whole transport movement might have failed, because it was essential to quick transportation that the troops should be ready for the ships."

The Quebec Bridge.

The St. Lawrence Bridge Company has issued a handsome booklet descriptive of the Quebec Bridge. It is printed in two colors on coated paper and embossed cover. A large number of full-page illustrations are included, which add a great deal to the interest and value of the book. These illustrations are from photographs by E. M. Finn, staff photographer of the St. Lawrence Bridge Company, and are excellently selected to show the progress of the work. A number of pages are devoted to the history of the bridge, its design and erection, tables of weights, summary of progress dates, description of the hoisting of the central span, and other interesting details.

Machine for Testing Lubricants.

A machine has been constructed by a firm at home for testing the properties of lubricants. The construction of the machine is on the following lines: The chief part is a pendulum hung on a bearing on a shaft rotated by means of pulley. The bearing is embraced by two brasses, to which pressure can be applied by a spiral spring inside the pendulum, the regulation being effected by a milled-head screw. When the shaft is rotated the friction between it and the brasses causes the pendulum to set itself a certain number of degrees out of the vertical, and this distance, together with the pressure on the journal, give the coefficient of friction, from which the friction-reducing value of the lubricant between the shaft and bearing can be obtained.

Railway Business Association.

Over 200 members of the Railway Business Association met at Chicago January 9. The reports of the various committees were adopted. Strong resolutions were adopted fovoring the speedy enactment of needed railroad legislation, and the sharing by the Government of the present excess cost of work. The officers elected were as follows: President, Alba B. Johnson, president of the Baldwin Locomotive Works, Philadelphia, and vice-dents as follows: J. C. Bradley, president of the Pratt & Letchworth Company, Buffalo; Robert F. Carr, president of the Dearborn Chemical Company, Chicago; George W. Simmons, vice-president of the Simmons Hardware Company, St. Louis, Mo.; W. W. Willitts, president of the Adams & Westlake Company, Chicago; W. W. Salmon, president of the General Railway Signal Company, Rochester, N. Y.; K. Taylor, president of the Taylor Wharton Steel Company, High Bridge, N. J., and A. L. Humphrey, president of the Union Switch & Signal Company, Pittsburgh, Pa. M. W. Clayton, of New York, was elected treasurer.

Hardening a Hammer

When the hammer has been heated slightly, more than what might be considered a good uniform hardening heat, dip the small end almost up to the eye and cool as quickly as possible by moving it around in the hardening fluid or dip, as it is called in the shop. Then dip the large end, which in the meantime will have cooled to a slight extent. It will be noted that the heat remaining in the eye of the hammer will draw the temper quicker in the small end of the hammer so that it will be too hard. The operation requires quickness and carefulness. The result will be that the hammer is hard where it should be hard, and also free from the danger of cracking in the eye.

Mr. McAdoo's Last Message.

Mr. McAdoo in a lengthy statement sets forth his views in favor of extending the period of governmental control to five years, and adds that those who may oppose an extension of five years should face the situation squarely and acknowledge that they prefer the immediate return of the railroads to private control under the old conditions without remedial legislation. It is idle to talk of a return to private control under legislation which will cure the defects of the existing laws. There is neither time nor opportunity for such legislation at present. It is impossible and hopless for the Government to attempt the operation of the railroads for twenty-one months after peace under the present law. Therefore, the country should squarely face the condition that the railroads must promptly go back into private control with all existing legal difficulties unless the only practical alternative, viz., an extension of time, is promptly granted.

I hope that the Congress in its wisdom will grant a five year period for a test of unified railroad operation under proper provisions of law which will make that test effective and at the same time take the railroad question out of politics while the test is being made. Unless this is done, I do not hesitate to say the railroads should be returned to private ownership at the earliest possible moment. The President has given me permission to say that this conclusion accords with his own view of the matter.

Railroads Oppose McAdoo Plan.

Thomas De Witt Cuyler, of Philadelphia, chairman of the railway executive advisory committee representing 125 roads, which include about 92 per cent of the mileage of the country, issues a statement that a custom has been reached that there is sufficient time under the terms of the present act to fully consider the railroad situation in all its aspects, and to arrive at a plan that would be just to the country as represented by its shippers and the public at large, and on the other hand to the security holders and shareholders and employees of the railroads. They are in full accord with the President in his statement as follows:

The one conclusion that I am ready to state with confidence is that it would be a disservice alike to the country and to the owners of the railroads to return to the old conditions unmodified. These are conditions of restraint without development. There is nothing affirmative or helpful about them. What the country chiefly needs is that all these means of transportation should be developed—its railways, its waterways, its highways and its countryside roads.

"Some new element of policy is therefore necessary—necessary for the service of the public, necessary for the release of credit to those who are administering the railways, necessary for the protection of their security holders. The old policy may be changed much or little, but surely it cannot always be left as it was. I hope that the Congress will have a complete and impartial study of the whole problem instituted at once and prosecuted as rapidly as possible.

"They feel that to at present extend the time would simply lead to delay and confusion, demoralization of the organization of the roads, both on their corporate and operating side, and defer indefinitely a satisfactory settlement of this great problem.

"They regret to differ with the Director-General, recognizing the able way he has managed the roads during the period of Government control, but they feel confident that it would be unnecessary and unwise to extend the period of control beyond the time now provided for under the act."

Mr. Shonts on the Railroads.

Theodore P. Shonts, President of the Interborough Rapid Transit Company, says that the great fact about government operation is the inevitable tendency toward extravagance and inefficiency. If the deficit from operations can always be made up out of taxation, if there is to be no reward for economy and forethought, it is impossible to expect careful watchfulness over expenditures. The supreme test which we in this country must apply to our plan of dealing with this whole question must be this: which plan will provide the necessary transportation at the lowest possible cost?

This means that we must not alone make the best and most economical use of existing facilities, but we must provide the new facilities needed for the future development of our country. We cannot here view the question as one might in England or France, where the necessary railroads are already built. How are we to develop our existing roads, and how are we to build our new railroads? The heart of the problem is this: Shall it be by the log-rolling and pork-barrel methods under which we have developed our postoffices, our rivers and our harbors, or shall it be by offering reasonable reward to those who by prudent forethought and initiative exert their imaginations and spend their money in developing the country?

Theodore H. Price on the Railroads.

Theoretically it is debatable whether the best results can be secured under private or Governmental control, but practically no such choice can be made. We live under a democracy which, despite its faults, none of us would exchange for an autocracy, and a majority of the people are and probably always will be opposed to the creation of privately owned monopolies.

In so far as the railways are concerned, this opposition is especially determined, for it is perhaps more true of corporations than of individuals that society is disposed to visit the sins of the fathers upon the children and assume that a railroad will always be predatory because most railroad managers used to be unscrupulous politically if not in their treatment of the public. As a matter of justice, it must be admitted that the ethical standards of railroad business have been greatly advanced within the last decade; but, granting this, most students of political conditions in this country will admit that within the present generation it would have been impossible to secure legislative authority or judicial sanction for a consolidation or combination of the American railways under private or even quasi private control.

As it is, Congress could only be induced to grant the President the temporary control of the railroads that he at present exercises through the Director General as a war measure, and everyone is now asking whether that control will be continued more than 21 months after peace shall have been reestablished.

An answer to this question is impossible, and I shall not attempt it.

The Director General is administering the law as it is written, leaving public opinion upon the question of Government versus private control to shape itself. It is, however, only fair to point out that the limitations of the statute, and especially the provision which contemplates the return of the railway properties to their owners 21 months after peace, make it impossible to undertake many improvements that would greatly increase efficiency and reduce the cost of operation for years to come.

It is, however, doubtful whether those who own the properties will desire to take them back at the end of the prescribed period even if the people are willing that they should be returned.

It is as yet too early to expect dividends from it, but when the reestablishment of peace shall make it possible to deal deliberately with the many problems whose solution could not even be considered while the exigent demands of war had to be met, it will be time enough to decide whether it is in the best interest of the people that a natural monopoly, such as our railroads have come to be, should be managed by the Government or by private enterprise.

The great thing in this world is not so much where we stand as in what direction we are moving.

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Dr. Angus Sinclair.

We have found it impossible to acknowledge receipt of the sympathetic expressions of regret at the death of our editor-in-chief that have come to us from all over the country, and we trust that our readers and other friends will kindly overlook our seeming neglect if we should fail to do all that is proper and becoming in the sad emergency. In view of the great and well deserved popularity of Dr. Sinclair's life work among railroad men, something of this kind was to be expected, but it is particularly gratifying to observe that the engineering press has given unanimous and eloquent emphasis to the enduring quality of his work, which, in an age of rapid improvement, is an added proof that he was a pioneer in the study and development of many practices pertaining to locomotive operation which have now become well established, and his influence will long be felt in practical railroad operation.

Federal Control

The report of the Director General of Railroads, a condensed abstract of which appears elsewhere in our pages, is of particular interest, especially in that portion referring to the mechanical department of railways, and it is only simple justice to state that the services of Mr. Frank McManamy, manager of the locomotive section, have been beyond praise. Whatever action Congress may take in the matter of passing the railroads back to their owners within the specified time as originally agreed upon, or whether in its opinion the matter may be delayed, lessons have been learned that will not likely be forgotten. These lessons, conveying as they do vast improvements in means and methods, are the natural outgrowth of the control of the railroads under a single head, and could not have been accomplished under any other condition, and the opportunity for improvements should not be set down to the ground of incapacity of those who have managed the railroads under separate control. Under such conditions co-ordination of operation, and even standardization was not to be expected.

Apart from these considerations, the work accomplished by the railroads in the period of stress through which the country has passed, has been admirable. The general spirit of the railroad men has been equal to the heroic advance of our armies in battle. Indeed the soldier and the railroader has been one in trial and in triumph, one in hope and in destiny. We live in a heroic age, and whether it is grappling with an insolent and barbarous foe, or with the titanic forces of nature, the American spirit is not surpassed by the Spartans at Thermopylae.

Government Control and Private Ownership.

In regard to the Federal control of the railroads, we cordially agree with all of the metropolitan and other leading journals that when the Government took control of them conditions were far from being satisfactory. The regulations were excessive, and they operated so as to create expenses, in some measure by compulsory advances in wages, while at the same time refusing to grant the adjustment of rates which would have kept receipts and expenditures at a reasonably reciprocal balance. The President was empowered to assume control and then adjusted railway charges to railway costs. He could not force the Interstate Commerce Commission to act favorably upon an effort of the owners of the properties to make similar changes in the rates. In the face of this absolute control of rates the deficit as shown in the reports is enormous.

It is universally admitted that changes in the system of regulation are absolutely necessary in the public interest. Important alterations in the laws, and particularly in the spirit and methods of their administration, should be made before the expiring of government control, but it is still of great importance that, as as a matter of fair dealing, the railroad properties should be returned to their owners. This would immediately insure the resuming of normal industrial relations and methods and should not be postponed for any other reason less vital than that which called for the transfer in the face of national danger. It would be well if Congress should pass the needed legislation. Delay on the part of our legislature should not be an excuse for breaking the original agreement.

As already stated, it was the Federal power that commanded the advance in wages. In view of the advanced prices of commodities, it was high time, but it was also the same power that withheld the adjustments of freight rates which the President saw at once was necessary to meet the needed obligations. The difficulties that threatened the railroads a year ago had no other cause than this. It is not only against reason and common sense that great private properties should be held by the Government for seven years after the event which created the emergency, but the idea itself is a menace to the organic principles underlying the splendid fabric of the form of government under which we live.

Is Science of Practical Use?

Many persons engaged in the activities of the industries and the arts doubtless look upon Science as something worthy of respect but scarcely having to do with their bread and butter. It may interest these and others, perhaps, to consider how scientific facts do enter intimately into the everyday life. It will hardly be practicable in the present article to do more than illustrate the point by one or two cases.

There is nothing more practical than foundry work. But the foundry-man has to do continually with a matter that is ultra-scientific. We refer to the expansion and contraction of metals under the influence of heat and cold. Science—particularly, physics—has been at great pains, not merely to note the broad fact that metals increase in length, breadth and thickness as they are heated, and decrease in length, breadth and thickness as they are cooled off—physics has noted not only this large fact, but has given much attention to measuring the rate.

Thus, it has been ascertained that cast-iron adds about 0.00000589 of its original length to itself with every degree Fahrenheit of its rise of temperature. As cast-iron passes through 2,300 degrees, F., in going from the temperature of the room to the melting point, a considerable total is added. This means that the molten iron in the furnace occupies distinctly more space than did the same metal when cold. Now when this molten mass cools off, there will be a shrinkage corresponding to the previous expansion and just about wiping it out. That is, the total

amount of shrinkage will about equal the total expansion. Under favorable circumstances, the length, breadth and thickness will each shrink at the same rate, as compared together, and at the same rate as that by which the expansion went on. A little consideration will show, however, that the conditions may sometimes be such that one or two of the dimensions may, for a time, remain unchanged, the shrinkage all occuring in the others. Thus, a metal heated up beyond its melting point will, upon cooling, tend to keep its length and width as it cools down to the melting point. The force of gravity and the liquid condition keep these dimensions the same. The total shrinkage through this heat region will, accordingly, occur in the thickness alone. The mass will, in fact, shrink in thickness at about 3 times the regular rate.

In a foundry mold, the molten metal will fill out the spaces *when the metal is first poured*. And, as long as it is molten, it will tend to keep them filled during shrinkage, if a proper head or gate is arranged. But *after* the metal solidifies, conditions will be different. Gravitation can't succeed very well with causing solid metal to fill the spaces. Consequently, shrinkage will now have the effect of making the metal draw away from the sides of the mold. There may be so much shrinkage that a good casting will be hard to make. Now, it so happens that metals differ greatly in the *amount* of shrinkage they undergo from the point at which they get solid to the ordinary temperature of the atmosphere. We give herewith a tabulation covering this matter for a number of metals used in making castings.

Shrinkages in Mold

Metal	Inches of shrinkage per foot
Cast-iron	0.125
Malleable iron	0.125
Aluminum (casting alloy)	0.156
Copper	0.1875
Brass	0.1875
Aluminum (pure)	0.2031
Steel	0.250
Zinc (casting)	0.3125.
Lead	0.3125

Variations In the Freezing of Heated and Cold Water

It may not be as generally known as it should be that during a sudden cold snap pipes containing hot water burst with much more frequency than in the case of pipes through which cold water only passes. Experiments have shown that hot water falls in temperature several degrees below what is called the freezing point before it begins to solidify, and that the ice thus formed is perfectly solid and transparent. Ordinary cold water, on the other hand, begins to congeal as soon as the freezing point is reached, and the ice thus formed is full of air bubbles, and generally of a soft appearance.

It will be readily understood that the air bubbles, in addition to impurities that may be in ordinary water, forms a nuclei of crystallization. The formation of ice thus begins sooner and proceeds more slowly than if these were absent, and the ice thus formed is more mobile, so that the pressure from the ice is not so severe. Hot water, on the other hand, is to a large extent free of gas particles, which have passed off during the process of heating, and the freezing of this water does not take place gradually, but almost all at once, with somewhat of an explosive effect, and there being no cushion of gas bubbles to take up the effect, the result is that if the expansion of the body of water incident to freezing is sufficiently strong to overcome the resistance of the metal in the pipe, a rupture will occur.

This has been found by passing a current of air through the water that had been heated as it approached the freezing point, when it was found that the water to which the air had been applied acted as if the water had not been heated at all, and froze slowly with the usual amount of gas molecules located in the ice.

This fact should be borne in mind by those having charge of heated locomotives or other appliances to which pipes are attached through which heated water may pass, and care should be taken that when the appliances are not in action, they should be carefully drained and kept free from the possibility of collecting water.

Railroad Men Winning the War

In the course of a discussion on "What railroad men have done to win the War," at a recent meeting of the Central Railway Club held in Buffalo, N. Y., Harry D. Vought, secretary said "that with the closing of the hostilities, we can make affirmative response in saying that the railroad man has done it. While not a railroad man in the technical sense, it has been my privilege to know something of what railroad men have done, and it can be truthfully said that, without the response they have given, without any regard to government ownership or control or supervision of railroads in this country, we would have had a sorry time in attaining the splendid achievements that marked the work of the railroad men of this country, before ever one shot had been fired by an American, before ever America thought of going into the conflict. I believe it can also be said, that they saved France and Great Britain from the disaster and defeat that was staring them in the face after the great and noble struggle they had made to conquer the devils who had provoked and caused the war! Now, the railroad men having done it, what can he do to assist in meeting conditions which are the outcome of what we have passed through? The railroad man did it, before; the railroad man will do it again. He will be one of the great factors in the settlement and adjustment of conditions which are the outgrowth of the war, and equally a factor in the restoration of normal conditions, which must follow the reconstruction period. He will have a voice, he will have an active part and he will render great and valuable service in the solution of problems, greater perhaps than those which confronted the authorities at Washington before they decided to have a hand in the conflict. It should be said of railroad men, as one of the best tributes that can be offered for them, that they have been responsive to every call made by country or humanity. In every disaster that has occurred in this or any other country, where they were called upon to hasten succor and relief, they have been just like the lighting of a match, quick on the trigger, active in every part where they were needed, and the railroad men of America, to say nothing of those abroad, can always be relied upon to be the quickest to answer the call to duty."

Water Circulation.

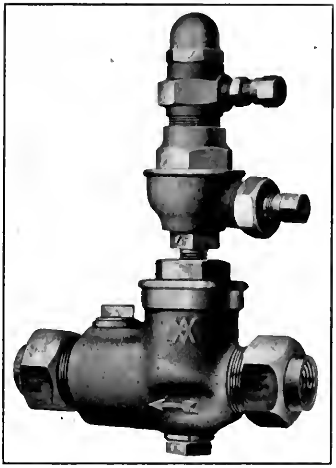
Every locomotive engineer knows that the boiler of a locomotive steams more freely when means are provided for promoting circulation of the water, than when the water is permitted to be inert on the heating surfaces. When the water-feeding injector first came into use many locomotive engineers objected to using and caring for it on the ground that it was an extra and unnecessary apparatus to care for, but extended experience demonstrated that the boilers fed by injectors steamed more freely than those fed by force pumps. There was at times on some roads considerable controversy on the question of why a boiler fed by an injector should steam more freely than one fed by pumps, and the question remained unanswered to many engineers, but we always believed that the superior steaming qualities were due to the increased boiler circulation that resulted from the use of the injector.

We are convinced that a considerable portion of the boiler saving produced by the use of the superheater is due to the improved water circulation that results from a superheater being placed inside of the boiler. The fact that the water is kept in movement with the charging flow of water coming in contact with the hot surface must produce greater evaporation than when sluggish movement keeps the same body of water in contact with the evaporator surfaces. This is a matter that may not have been fully investigated and has not been considered so important as it deserves to be.

Air Brake Department

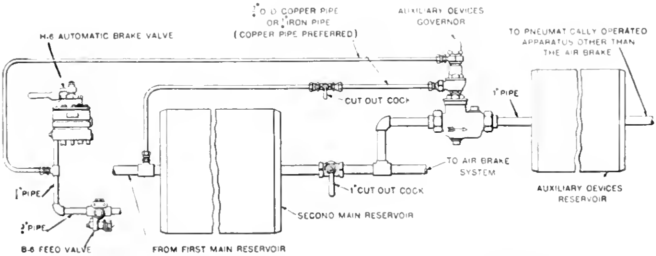
"Parasite" Reservoir Governor—Questions and Answers Including a Special Question in Regard to Brake Pipe Leakage and Charging Time.

The increasing variety of uses to which compressed air is being called upon for service on locomotives for pneumatic devices other than the air brake, such as the reversing gear, bell ringers, water scoops, and other appliances, has reached a stage when it has been considered neces-



PARASITE RESERVOIR GOVERNOR.

sary to protect the supply of air for the air brake from becoming depleted from the operation of these smaller devices, or "parasites" as they are called. To accomplish this protection, the Westinghouse Air Brake Company has developed a device known as the "Parasite" Reservoir Governor, the application of which has already met with much favor.



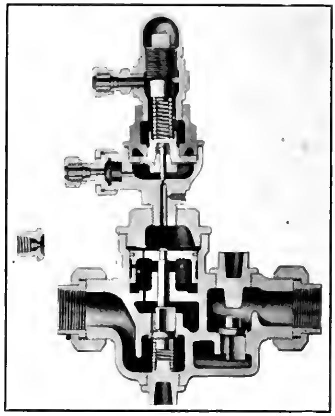
APPLICATION OF PARASITE RESERVOIR GOVERNOR (DIAGRAMMATIC).

The device is so designed as to permit charging of the parasite reservoir, or reservoir from which the "parasites" are supplied, from the main reservoir, only when the main reservoir pressure is above a certain predetermined amount sufficient to safely operate the brakes. The air operated devices on the locomotive are therefore prevented from taking air from the main reservoir pressure, and in consequence from the brake system itself.

The governor consists of a diaphragm portion, which is identical with the diaphragm portion of the Westinghouse steam compressor governor, and a body or valve portion which embodies a piston, a spring valve and a non-return check valve. Pipe connections are made, as illustrated, from the main reservoir to the diaphragm portion, and to the body portion, and also from the "parasite" reservoir to the body portion, but the diaphragm valve 33 will remain seated until main reservoir pressure reaches that for which the regulating spring 19 is adjusted, when the valve will unseat, allowing air to flow to the top of piston 6. The piston is thereby moved downward, opening valve 5, at the left, and allowing the air in the main reservoir to flow direct to the "parasite" reservoir past the non-return check 5, at the right.

When air is being taken from the "parasite" reservoir for the operation of the "parasites," the pressure will fall a like amount in both reservoirs until it reaches that for which the governor head is set, when diaphragm valve 33 will seat and prevent further flow of air from the main reservoir. Should the pipe between this governor and the "parasite" reservoir break, the air in the main reservoir will not be lost because the diaphragm valve will seat as soon as the pressure in the "parasite" reservoir governor drops to that for which the regulating spring is set. Should a main reservoir pipe break, the non-return check valve 5, at the right, will prevent the loss of "parasite" reservoir air.

It will thus be readily seen that in addition to the primary function of protecting the brake system, against depletion of air supply due to the use of "parasite" apparatus, this governor also prevents loss of air from both reservoirs if the air supply should be reduced from any other cause, as from the use of the air brake, or from breakage of the pipe connected



SECTIONAL VIEW OF PARASITE RESERVOIR GOVERNOR.

to either reservoir. Thus, should the "parasite" reservoir pipe break, or the pressure become reduced abnormally through operation of the "parasites," the "parasite" reservoir governor would prevent the loss of the main reservoir air below a point necessary for the operation of the brakes. Furthermore, should the main reservoir pressure be lost through the breakage of a main reservoir pipe, or be reduced abnormally from any other cause, the "parasite" reservoir governor would permit the loss of "parasite" reservoir pressure, thereby making it possible to reverse the engine if provided with a pneumatic reversing gear, or to operate the other "parasite" apparatus.

It will thus be seen that the device meets the requirements of the situation for which it is adapted with that completeness of exact degree of operation which is so marked a feature in the air brake appliances that are constantly being added to by the skilled engineers engaged in the multiplex experiments conducted by the Westinghouse Air Brake Company extending over a period of more than thirty years.

Special Air Brake Question from Paul W. Kiefer, New York.

Assuming a train of 50 freight cars having standard 10 in. equipment, either West. or N. Y., and with total brake pipe and auxiliary reservoir capacity of 90 cu. ft. (155,520 cu. in.).

Leakage of 10 in. gauge pressure per minute from 70 in. brake pipe pressure will permit the escape of 105,753 cu. in. free air, providing auto brake valve handle (ET or LT) is on lap, feed valve cut out.

1st. Would like very much to find out how to calculate the amount of free air that will escape from the *same defective brake pipe* if the initial brake pipe pressure is something else, say 50 in. gauge. To make myself clear, I do not mean leakage of 10 in. gauge pressure per minute from 50 in. brake pipe pressure, as in this case the amount of free air escaping would be practically the same in both cases. If the same defects are present in our brake pipe the leakage from 50 in. brake pipe pressure will be something less than from 70 in.

This is the quantity I wish to calculate, omitting heat.

2nd. Taking the same train described above and using a W 8½ in. C. C. compressor capable of delivering 115 cu. ft. (198,720 cu. in.) free air per minute, say at boiler pressure of 180 in. Loco. having ET or LT equipment, and two main reservoirs, total capacity of 60,000 cu. in., charged to 130 in. gauge pressure.

Couple this loco. to the above train and place auto. brake valve handle in "full release" position. The entire system (locos. and cars) will equalize at 25.56 gauge pressure.

If there were absolutely no leakage, retardation or friction, and with pump running at uniform speed and delivering 115 cu. ft. free air per minute, 3,27 minutes would be required to pump up this system (loco. and cars) from 25.56 to 70 lbs. gauge pressure, auto. brake valve handle in "full release" and neglecting heat.

Now, we will neglect leakage entirely, however, there will be a considerable amount of friction through piping, brake valves, etc., and retardation due to feed grooves in triple valves, etc.

Would like to find out if you have any data or information showing the additional time required to overcome this friction and retardation, that is, how much time should be added to the 3.27 minutes to obtain the actual (approx.) time required to pump up this system from 25.56 to 70 lbs. gauge pressure, under the above conditions; can this be calculated in any way?

Would like this information in connection with a pump capacity problem I have before me. If consistent and within the bounds of your department would like to get whatever information you may see fit to furnish at as early a date as possible, and I assure you that your efforts in this regard will be appreciated.

Answers to Questions on Brake Pipe Leakage and Charging Time.

In this example the brake pipe and auxiliary reservoir volume of a 50-car freight train of 10-in. equipment has been taken as 96.8 cu. ft. instead of 90. This is based on a 40-ft. car with 2,440 cu. ins. auxiliary reservoir volume and 900 cu. ins. for the volume of the brake pipe, branch pipe and hose connections. With the locomotive and tender brake pipe, and the distributing valve pressure chamber volumes considered, the total volume would be about 98 cu. ft.

(1) It is understood that another way of expressing the first question asked is: How would the leakage from any pressure be determined when the leakage from one pressure is known? While the surge of air from the front of the brake pipe to the rear, the functioning of the quick service port and various other actions during a leakage test make it difficult to determine the actual leakage drop, it will be assumed that the leakage stated is exactly that amount throughout the train, that the pressure is the same in all sections of the brake pipe, and also that 10 lbs. drop from 70 lbs., as stated, means that the whole system beyond the brake valve leaked from 70 lbs. to 60 lbs. in one minute.

An approximate formula to determine the leakage at any pressure, under he above conditions, is:

$$L_2 = \frac{(P_2+15)}{(P_1+15)} L_1$$

Where

L_2 = Leakage drop from *any pressure* P_2 desired to be known, in pounds per minute.

L_1 = Leakage drop from a known pressure P_1, in pounds per minute.

P_2 = Any pressure (gauge) from which leakage L_2 is sought.

P_1 = Any given pressure (gauge) from which leakage L_1 is known.

EXAMPLE.

The brake pipe pressure drops 10 lbs. a minute from a test pressure of 70 lbs. gauge. What would the drop be from a test pressure of 50 lbs. gauge?

$$L_1 = 10$$
$$P_1 = 70$$
$$P_2 = 50$$

Then

$$L_2 \quad \frac{(50+15)}{(70+15)} 10 = 7.65 \text{ lbs. per minute.}$$

(2) If 98 cubic feet are taken as the total brake pipe and auxiliary reservoir volume, 60,000 cubic inches as the volume of the main reservoir, with the former empty and the latter at 130 lbs. gauge pressure, the equalization pressure will be about 34 lbs.

The portion of the compressor capacity of 115 cubic feet of free air that will be available to that portion of the brake system beyond the brake valve during the charging will be (98/132.7) × 115 = 85 cubic feet of free air per minute, where 98 cubic feet are the brake pipe and auxiliary reservoir volume, 132.7, the 98 plus the main reservoir volume in cubic feet, and 115, the compressor capacity. Now, pipe friction does not evidence its effect to any considerable degree in a train of 50 cars or less; and hence the brake pipe will permit the admission of more than 85 cubic feet of free air until the brake pipe pressure on the end of the 50th car has risen to 50 lbs. When this pressure is reached, with the train under consideration, the pipe will permit just 85 cubic feet of free air to enter it. Then, the front end of the train will be charged fully (70 lbs.) and the rear end to 50 lbs., while the pressure on the intervening cars will be at some intermediate stage between these two. From this point on, pipe friction becomes the limiting factor. The charging for this condition is calculated by somewhat complicated formulæ. It may be stated, however, that with no leakage, with the front end of the train fully charged and with the rear end at 50 lbs., the charging of the train under consideration would be completed in 1.6 minutes.

QUESTIONS AND ANSWERS

Locomotive Air Brake Inspection.

(*Continued from page 19, Jan., 1919.*)

638. Q.—How does free air enter a cylinder through the receiving valves?

A.—The movement of the piston from the end of the cylinder tends to create a vacuum, permitting the atmospheric pressure to lift the receiving valve and enter the cylinder.

639. Q.—How should an air compressor be dismantled for repairs?

A.—By removing all parts except the steam cylinder and air cylinder from the center piece.

640. Q.—What part first?

A.—The air cylinder head, in the event of valve cages in the cylinder head, they may first be removed from the head

641. Q.—What should then be done?

A.—Any piston operating a reversing valve rod, or valve stem should be moved to the center of its cylinder, after which the valve rod or valve stems should be removed.

642. Q.—What operation follows?

A.—The removal of the steam head, air pistons, steam pistons and rods, air valve caps and cages, valves, and their seats if worn or loose.

643. Q.—How should air pistons be removed?

A.—After the piston rod nuts are re-

moved, a piston jack or yoke should be used.

644. Q.—How is such a tool fastened to the air piston?

A.—By tap bolts screwed into the threaded holes in the piston.

645. Q.—How is the jack or yoke used for the removal of the piston from the rod?

A.—The set screw is tightened against the rod and given several hard blows with a hammer which will generally loosen the piston from a taper fitted rod.

646. Q.—What advantage has this method over one of using a maul to drive the rod out of the head or piston?

A.—It prevents the damage to the piston rod that is caused by battering it when knocked loose with a maul.

647. Q.—What is the advantage of the taper fit in fastening the piston on the rod?

A.—It absolutely prevents the breaking off of the air piston from the rod.

648. Q.—What should be done with the compressor after it has been dismantled?

A.—All parts including oil cup and strainer, should be placed in a vat of boiling lye and thoroughly cleaned.

649. Q.—And after all parts are clean?

A.—They should be washed, preferably with hot water.

650. Q.—What else should be done in the way of dismantling after the compressor is returned to the repair room?

A.—The cylinders should be removed from the center piece for an examination of the gaskets.

651. Q.—In what way should taps or dies be used at this time?

A.—All threaded holes should be re-tapped and all bolts should be re-threaded and nuts re-tapped if necessary.

652. Q.—What should be done in the event of stripped or broken threads in holes?

A.—Drill and tap the holes to a sufficiently larger size, and plug with brass, then drill and tap the brass with standard size tap.

653. Q.—Of what advantage is this?

A.—It permits of the use of standard bolts throughout.

654. Q.—What is now necessary in the way of inspection?

A.—All parts should be carefully examined to note their condition before an attempt is made to assemble any part of the compressor.

655. Q.—What may be done in the event of stripped or damaged threads in the valve chamber cavities of the air cylinder or the reversing valve or steam valve chamber?

A.—The damaged or removed metal may be replaced with the oxy-acetylene method and the part may then be machined and tapped to the original standard size.

656. Q.—What if any of the bolting lugs are found broken off?

A.—They may be replaced with the same welding method.

657. Q.—If all parts are found to be in good condition as to bolting lugs and threaded portions?

A.—The cylinders should be calipered.

658. Q.—What if they are found to be out of round or parallel 1/32 ins. or more?

A.—They should be re-bored.

659. Q.—How should the cylinders be set up in the machine?

A.—They should be centered by the counter bore or centering groove at the end of the cylinder next to the center piece.

660. Q.—What attention should be given the center piece?

A.—The stuffing box nuts and glands should be examined for wear, and particular attention should be given the threads of the stuffing boxes and nuts.

661. Q.—And if nuts are found to be excessively loose on stuffing boxes?

A.—One or both parts should be renewed.

662. Q.—How should the stuffing boxes be removed for renewal?

A.—By drilling a considerable portion of the stuffing box with a large drill, care being taken not to drill into the center piece.

663. Q.—What is the object?

A.—To have less metal to cut away with the gouge chisel, which will reduce the liability of damaging the threads in the center piece.

664. Q.—What is the most important observation in connection with the application of a new stuffing box?

A.—To see that it seats properly against the center piece and that it does not extend past the face of the center piece into the cylinder.

665. Q.—What would be the result if it did extend into the cylinder a fraction of an inch past the face of the center piece?

A.—At certain times, or when the compressor is first started, the main piston would strike the stuffing box instead of the center piece, and result in loosening the stuffing box or the steam piston on the rod.

666. Q.—How should a stuffing box be secured in the center piece?

A.—With a dowel pin, but on repaired work it is better to tap bolt threads into the hole for the dowel pin and fasten the stuffing box in this manner.

667. Q.—How is this done in detail?

A.—After the hole is tapped, a bolt is screwed into it and marked where it comes flush with the center piece, then the bolt is removed and weakened by sawing it with a hack saw a trifle below the mark, after which the bolt is screwed into place and twisted off, and a portion of the stuffing box brass is riveted over the portion of the bolt remaining in the plugged hole.

668. Q.—What attention should be given to air valves located in the center piece?

A.—It should be noted that they have the proper lift, that the wings are not loose enough in the seat to permit them to "wobble," that they do not have more than a 1/8 in. wide bearing surface on the seat and that the boss on the valve is cross slotted.

669. Q.—If a valve seat is difficult to remove, from corrosion caused by heat, how is the removal sometimes facilitated?

A.—By heating the outside part of the center piece or cylinder with a gasoline torch.

670. Q.—What is the proper lift of air valves?

A.—3/32 in. for the 9½, 11 and 8½ ins. compressors, and 5/32 in. for the 5B and 6B compressors, 1/8 in. for the intermediate, and 5/32 in. for all others of the 10½ in. compressor.

671. Q.—How is the lift of air valves obtained?

A.—By filing or grinding off from the boss of the valve, it should not be obtained by facing off the valve chamber cap.

672. Q.—How is the lift measured?

A.—With a gauge made for the purpose, the difference in distance between the top of the valve and the face on which the cap rests and the distance from the face of the cap to the valve stop represents the lift of the valve.

673. Q.—What precaution must be taken in filing a valve to obtain the proper lift?

A.—To see that it is filed squarely, otherwise different measurements will be obtained.

674. Q.—What is to be observed in connection with the contact of the valve in the valve chamber cap?

A.—That the valve does not engage the lugs of the cap that hold the valve seat in place.

(To be continued)

Train Handling

(Continued from page 20, Jan., 1919.)

658. Q.—What is the difference between running and holding positions?

A.—In the former, the release pipe port is open releasing the engine and tender brake; in the latter this port is closed, holding the brakes on if previously applied.

659. Q.—What is lap position used for?

A.—For holding the engine and train brakes applied.

660. Q.—And service position?

A.—For applying the brakes during ordinary service stops.

661. Q.—And emergency position?

A.—For applying the brakes quickly in actual cases of emergency.

662. Q.—At what other time should emergency position be used?

A.—In case of a parted passenger train, or brakes on a passenger train applying in emergency.

663. Q.—What does the equalizing discharge valve do?

A.—Mechanically measures the volume of air discharged from the brake pipe during service operations.

664. Q.—What three principal pressures are divided by the brake valve on lap position?

A.—Main reservoir, brake pipe and equalizing reservoir.

665. Q.—What part of the brake valve separates the pressures?

A.—The rotary valve and seat and the equalizing piston packing ring.

666. Q.—What pressures does the packing ring divide?

A.—Brake pipe and equalizing reservoir.

667. Q.—What then occurs as the brake valve is moved to service position?

A.—The equalizing reservoir pressure is reduced through the preliminary exhause port, and brake pipe pressure lifts the equalizing piston and flows to the atmosphere.

668. Q.—How long does the piston remain off its seat?

A.—Until the brake pipe pressure has reduced to a point slightly less than that remaining in the equalizing reservoir when the valve handle was returned to lap position.

669. Q.—What are the movable parts of the application portion of the distribu'ing valve?

A.—An application piston, and application valve and an exhaust valve.

670. Q.—What positions do they assume in operation?

A.—Release, lap and application position.

671. Q.—What are the movable parts of the equalizing portion?

A.—The equalizing piston, equalizing slide valve and graduating valve, the emergency slide valve and brake cylinder check valve, and a piston valve in the safety valve.

672. Q.—What positions does it assume?

A.—Release, service, service lap, emergency and emergency lap.

673. Q.—What pressure is the safety valve of the distributing valve adjusted for in passenger service?

A.—68 lbs.

674. Q.—In freight service?

A.—The same.

675. Q.—What pressure is exhausted to the atmosphere by the safety valve?

A.—Application cylinder and application chamber pressures.

676. Q.—How does this control the pressure developed and retained in the brake cylinders?

A.—The pressure in the application cylinder governs the amount that will be developed in the brake cylinders.

677. Q.—What air pressures are separated by the application valve of a distributing valve?

A.—Main reservoir and brake cylinder.

678. Q.—By the application piston packing leather and ring?

A.—Application cylinder and brake cylinder.

679. Q.—By the equalizing piston and packing ring?

A.—Brake pipe and pressure chamber pressure.

680. Q.—By the exhaust valve, with the brakes applied?

A.—Brake cylinder and atmospheric.

681. Q.—What is the purpose of the application chamber of a distributing valve?

A.—An enlargement of the application cylinder volume for service operation.

682. Q.—What principal pressures are separated by the equalizing slide valve with the brake applied?

A.—Pressure chamber and application chamber pressures.

683. Q.—If the equalizing portion is in quick action position?

A.—Application cylinder and application chambers are also separated.

684. Q.—What pressures are separated by the emergency slide valve of the quick action equalizing cylinder cap?

A.—Brake pipe and brake cylinder pressures.

685. Q.—By the cylinder check valve, with the brake applied?

A.—Brake pipe and brake cylinder pressures.

686. Q.—How is a distributing valve cut out?

A.—By closing the stop cock in the distributing valve supply pipe.

687. Q.—How is it positively cut out, if it has a quick action cylinder cap?

A.—By closing the stop cocks in the brake cylinder pipes.

688. Q.—Why cannot the latter valve be positively cut out with the stop cock in the supply pipe alone?

A.—Because with an emergency application, the emergency slide valve of the quick action cylinder cap will be moved and admit brake pipe pressure to the brake cylinders.

689. Q.—Which is the larger of the two chambers of the distributing valve reservoir?

A.—The pressure chamber.

690. Q.—How does a brake pipe reduction affect a distributing valve?

A.—If sufficiently rapid, it reduces brake pipe pressure below that in the pressure chamber, permitting the higher pressure to move the equalizing portion to application position.

691. Q.—How does the brake then apply?

A.—Pressure chamber pressure flowing through the service port to the application chamber and application cylinder, forces the application piston to application position admitting pressure from the main reservoir to the brake cylinders.

692. Q.—How long will main reservoir pressure continue to flow into the brake cylinders?

A.—Until brake cylinder and application cylinder pressures become equal.

693. Q.—What then occurs?

A.—The application piston graduating spring moves the application portion to lap position.

694. Q.—How long will the portion remain in lap position?

A.—Until leakage reduces brake cylinder pressure sufficiently to permit the application cylinder pressure to again move the valve to application position, thus supplying the leakage.

695. Q.—How is the brake then released?

A.—By exhausting application cylinder pressure to the atmosphere.

696. Q.—In what positions must the brake valves be to permit application cylinder pressure to exhaust?

A.—Both handles must be in running position, otherwise the independent valve must be moved to release position.

697. Q.—What is the principle upon which an automatic brake operates?

A.—Upon the creation of differences in pressure between stored volumes of compressed air.

698. Q.—What are the limits for brake cylinder piston travel?

A.—4 to 6 ins. for the drivers and 6 to 8 ins. on the tender.

699. Q.—Will a brake release quicker when the travel is long or short?

A.—The locomotive and tender brakes will release quicker if the travel is short.

700. Q.—Why so?

A.—There will be less volume in the cylinder to exhaust than when the travel is long.

701. Q.—In service application, will brake cylinder pressure on cars and engine be uniform?

A.—Yes, if brake cylinder piston travel on cars is approximately 7½ or 8 ins.

702. Q.—Can the automatic brake valve be used to make a service application if the independent brake valve is in release position?

A.—No. Application cylinder pressure would escape through the independent brake valve exhaust port.

703. Q.—What returns the brake cylinder pistons to release position after the exhaust of air pressure from the cylinders?

A.—The cylinder release springs.

704. Q.—What holds the brake cylinder packing leathers against the cylinder wall?

A.—The packing expander ring.

(To be continued.)

Car Brake Inspection.

(*Continued from page 21, Jan., 1919.*)

601. Q.—In either case, how long would it actually take to charge a train of such cars from 0 to 70 lbs. pressure?

A.—As 24 cubic feet of free air per minute would be lost through leakage, 21 of the 45 only would be available for charging the train, therefore to furnish about 800 cubic feet of free air would require about 40 minutes time.

602. Q.—How long would it take an 8½ ins. compressor at 100 cubic feet of free air per minute to do this work?

A.—With this compressor there would still be about 75 feet of free air per minute available for charging the train, and its time for charging the train would be 800 divided by 75 or about 10 minutes.

603. Q.—What amount of free air would be required to recharge the train after a 15 lb. brake pipe reduction?

A.—One atmosphere, or 170 cubic feet.

604. Q.—How much work is this for the 11 in. pump, half the capacity lost through leakage?

A.—170 divided by 23 or over 7 minutes.

605. Q.—Why would this actually be done in a shorter time?

A.—Because the main reservoir would contain an excess pressure with which to release the brakes, and recharge the system, but this will be the time required to restore the air pressure lost through a 15 lb. reduction.

606. Q.—How much work would this be for the 8½ in. compressor?

A.—About 2½ minutes.

607. Q.—Assuming a main reservoir capacity of 60,000 cubic ins., or 35 cubic feet, and with excess pressure lost through frequent applications of the brake, what time will be required to charge the brake system and main reservoir combined from 50 to 70 lbs. with the 11 in. pump, and with the same amount of leakage previously assumed?

A.—This will require about 1½ atmospheres for the total volume of 205 cubic feet of space, or about 307 cubic feet of free air, and if the capacity of the 11 in. pump is reduced one-half by leakage, the time required will be 307÷23 or 13 minutes.

608. Q.—What does this emphasize?

A.—The importance of large capacity compressors for grade work.

609. Q.—If the main reservoir pressure was at 100 lbs., and the brake pipe pressure on this train 50 lbs., what would main reservoir brake pipe and auxiliary reservoirs equalize at, the pump not being considered as operating?

A.—170 cubic feet in train x 50 lbs. and 35 feet in main reservoir x 100 lbs., when added would equal 12,000 cubic feet of free air, and this divided by 205, the total feet of air space in the main reservoir and brake pipe would indicate that the pressures would equal at about 60 lbs.

610. Q.—How is the first atmosphere considered in this calculation?

A.—It is not considered at all, as the pressures involved are above the atmospheric line.

611. Q.—What is gage pressure plus atmospheric pressure termed?

A.—Absolute pressure.

612. Q.—Is there any difference in the operation of freight and passenger car triple valves?

A.—No, not between P and H valves.

613. Q.—How does a triple valve operate during a service brake application?

A.—When air pressure enters from the brake pipe, it is trapped in the auxiliary reservoir, and cannot be withdrawn at any ordinary rate without causing a difference in pressure between the auxiliary reservoir and brake pipe.

614. Q.—And this difference in pressure causes?

A.—A movement of the triple valve piston and slide valve to application position, admitting air pressure from the auxiliary reservoir to the brake cylinder applying the brake.

615. Q.—How is the brake then released?

A.—By restoring the brake pipe pressure sufficiently above that in the auxiliary reservoir to force the triple valve piston and slide valve to release position, or by reducing the auxiliary reservoir pressure by means of the release valve, in either case the movement will open the brake cylinder to the atmosphere.

616. Q.—What does the first movemnt of the triple valve piston toward application position result in?

A.—Closing the feed groove and moving the graduating valve to open the service port in the slide valve.

617. Q.—What movement then follows?

A.—When sufficient differential is obtained, the slide valve is moved connecting the service port in the slide valve with the one in the seat which leads to the brake cylinder.

618. Q.—What occurs if the brake pipe reduction ceases after a 5, 10, or 15 lbs. pressure has been withdrawn?

A.—The brake pipe pressure then remaining stationary, moves the triple valve piston to lap position against the weakening auxiliary reservoir pressure.

619. Q.—Does the triple valve slide valve move at this time?

A.—No, only the piston and graduating valve.

620. Q.—How far do these parts move?

A.—About 3/16 in. or merely enough to close the service port in the slide valve.

621. Q.—How long does the piston and graduating valve remain in this position?

A.—Until a further reduction in brake pipe pressure occurs, or until brake pipe pressure becomes sufficiently higher than auxiliary reservoir pressure to force the triple valve to move to release position.

622. Q.—How is an emergency application of the brake made?

A.—By a sudden opening of the brake pipe to the atmosphere.

623. Q.—The expressions "quick action" and "emergency" are sometimes confused. What may be understood from the two?

A.—That emergency is a condition under which the brake is to be applied with the maximum degree of force, and as a result the brakes on the train work in quick action.

624. Q.—What movement does the triple valve piston and slide valve make when quick action occurs?

A.—The piston and slide valve travel the full stroke compressing the graduating spring and a flow of air from the auxiliary reservoir unseats the emergency valve through the medium of an emergency piston, admitting a certain amount of brake pipe pressure to the brake cylinder and full auxiliary reservoir pressure is added to it.

625. Q.—Which pressure enters the cylinder first?

A.—Just a flash of auxiliary reservoir pressure as the slide valve passes service position, but the brake pipe practically equalizes with the brake cylinder before the auxiliary reservoir pressure becomes effective.

626. Q.—How much brake cylinder pressure is obtained as a result of quick action?

A.—From a 70 lb. brake pipe pressure in freight service, very nearly 60 lbs.

627. Q.—What is the purpose of venting brake pipe pressure to the brake cylinder?

A.—To positively continue quick action throughout the train, and develop this somewhat higher brake cylinder pressure for emergency stops.

628. Q.—If quick action originates at one triple valve will it then positively be transmitted to others?

A.—Yes, provided the triple valves are in a reasonable state of efficiency and that a number of brakes are not cut out consecutively so that the violence of the reduction is not thereby destroyed.

629. Q.—What is necessary to produce this action of the brake?

A.—A brake pipe reduction of about 8 lbs. per second.

630. Q.—What time will be required for this quick action to run throughout a train of 50 Cars?

A.—About two seconds.

631. Q.—What per cent. of the brake cylinder pressure is obtained from the brake pipe?

A.—In actual number of cubic inches of free air, the amount is almost equal.

(*To be continued.*)

Rapid Transit on Revised Principle

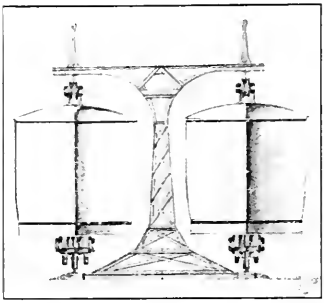
By ROBERT W. A. SALTER, London, England

The Kearney high-speed railway system may be looked upon as a fair solution to the problem of rapid transit in cities. For both elevated railroads and subways its adaptability appears to be remarkable, as will be shown in the following article, the material for which has been acquired by an interview with the inventor.

Mr. Kearney points out that the Interborough Rapid Transit Subway is the only underground railway in the world which is earning a return on the investment of more than 3 per cent. The conditions of location and service in the case of the New York Subway have no parallel in any other city, and it is only under such conditions of congestion that a subway on the existing system can hope for an adequate return. The Kearney gravity tube would, the inventor claims, enable large cities like Los Angeles, Milwaukee, Pittsburgh, San Francisco, St. Louis, etc., which at present have only their surface facilities, to enjoy the luxury of high-speed subways on a profitable basis.

Present-day operation of steam and electric railroads show no practical improvement in the matter of high speeds, Mr. Kearney asserts. In the Kearney high-speed railway system on the surface the cars operate upon a single bearing rail which takes the whole weight of the train. The cars are maintained in equilibrium by means of a single overhead guide rail. It is obvious that as these guide rails can be braced together for mutual support an important advantage is gained. The bracing together of the two guide rails for the lines in either direction results in a horizontal lattice girder 14 ft. across, which is strong in the direction required and light in construction, easily assembled and low in cost. This lattice girder is supported on stanchions which are erected at intervals of 60 ft. Treated as cantilevers these stanchions are designed to take a side-thrust of 12½ tons at the top before reaching the elastic limit of the metal. The maximum side-thrust ever likely to be put on any one of them would never exceed 2 tons; therefore a wide margin of safety has been allowed. To give vertical strength to the guide rails a short column is placed on either side of the stanchion from which tie rods forming a truss are connected to the rails which are thereby divided into spans of 20 ft. Adjustment is provided for both vertically and horizontally, so that the guide rails will take true alignment. On curves the whole superstructure is canted over to allow for the centrifugal effect of the ordinary maximum strain on that part of the line.

The so-called "gravity tube system" evolved by Mr. Kearney combines the advantages of both the shallow cut-and-cover system—as exemplified by the New York Subway—and the deep-level tubes—as on the Hudson and Manhattan Railroad. In the Kearney subway system the stations are either on or just below the surface of the street, and in the latter case the platforms can be reached by descending a short flight of steps. Between the stations the line descends by means of gradients of 1 ft. in 7 ft. to a depth of 90 ft. Through this arrangement the following important results are achieved: The cost of construction is greatly reduced; the cost of operation is also reduced; the speed of trains may be doubled. Construction costs are lessened by the absence of deep-level stations—which called for an enormous outlay when the Hudson Tunnel System was built and elevators and connecting passages. Cost of operation is reduced by the gradient system and its saving of something like two-thirds of the power which would otherwise be required to propel trains; while maintenance costs are lowered on account of the limited use of brakes, gravity being employed to stop the trains as well as to start them.

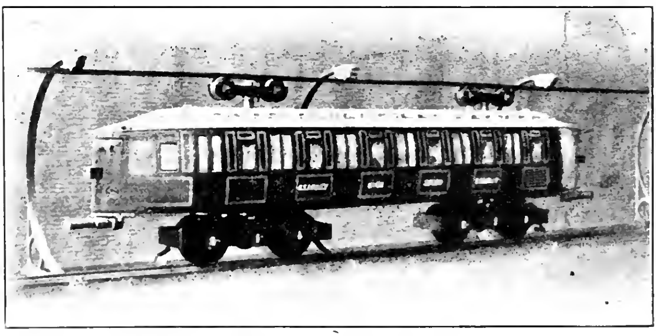


KEARNEY SYSTEM ON THE SURFACE.

Speed is increased by means of high rates of acceleration attainable with the use of gravity, which in turn enables a higher maximum speed to be reached. Mr. Kearney figures on a maximum speed of 60 miles an hour, to be attained in 23 seconds from the moment of starting. Schedule speeds would amount to from 30 to 40 miles an hour, according to the number of stops per mile, so that an overall speed double that of the existing methods would be accomplished.

Mr. Kearney's plan is that all stations should have three platforms, the middle one being the departure platform and the sides those of arrival. It does not require much logical deduction to enable any railroad man to grasp the utility of this. For an example of quick loading and unloading of passengers witness the results achieved at the Hudson Terminal in New York, where the platforms are arranged on this principle, and where trains are dispatched on a 90-second headway with an elapsed time of only one minute for loading and unloading.

The writer has had the privilege of seeing both the inventor's working model in London and the full-sized car No. 1 which has been constructed at Loughborough, England. The latter is 45 ft. in length and 8 ft. in width, with a capacity of seating 44 persons. The weight is 18 tons and the car is mounted on four wheels of 36 ins. diameter, the wheels being motor-driven. The seats are arranged transversely with a centre aisle. In all cars on Kearney city lines it is proposed to abolish end vestibules and the doors will be placed between each group of crosswise seats. In all there are to be six doors a side, which will prevent the possibility of a jam in any one part of the car. To eliminate air resistance and frictional losses the car is tapered at each extremity. Ball-bearings are fitted to all bearings, both on the under wheels and the guide wheels. This reduces friction.



A KEARNEY HIGH SPEED CAR.

Electrical Department

Fundamental Principles of the Coasting Clock

Last month we pointed out how the cost of operation of the electric elevated and subway systems had increased enormously without a corresponding increase in the unit fare. Economy is necessary and one way of gaining some is by reducing the waste of electrical energy in the transmission from the power house to the electric train, and another by the most economical operation of the train itself, so that the minimum power will be used to propel the train and maintain the schedules. One of the largest items in the cost per car mile is the cost for electric power, so that a saving in this item is beneficial. Some assistance must be given the motorman so that he can tell if the operation is economical. One method is by the use of the Rico Coasting Clock, which we described in detail. It records the amount of coasting time. With increased coasting time for the same schedule the power consumption is decreased.

This question of power economy is a very interesting one and as the previous article related mostly to a description and the operation of the Coasting Clock, we will go more into details and study further the "economies in railway operation." To better understand electric operation we should go back and cover the fundamental principles. There are many refinements in engineering work made possible when electric traction is substituted for steam. One of the most notable of these is the ability to calculate accurately, from design data, the speed, acceleration, power required and the size of equipment necessary to handle a given service. By making use of the railway motor characteristic curve a speed time curve can be drawn for the determination of schedules, etc. [We mentioned the speed-time curve in the last article showing how it was made up of acceleration, coasting and braking]. The method used is the same throughout the range of electric traction, whether it be for a street car or a high speed electric passenger train.

The railroad electrical engineer, in the study of the design and operation of an electric system, encounters certain fundamental and definite problems. Trains of various weights must operate over the road, around curves and up and down grades at speeds which are determined by schedules laid down by the time-table. The hauling of these trains requires electric locomotives of certain sizes which must be designed and built to meet definite specifications.

Before electricity was applied to transportation, the locomotive capacity was usually determined not by calculation, but by the cut and try method. Since electricity has been applied a careful study is made of the operating conditions. The grades, curves and speeds are considered and it is then possible, by calculations and graphic methods, to specify the size of the locomotive or car required to satisfactorily perform the service.

The amount of horsepower in electrical equipment and its capacity will depend upon the service conditions to be met. The severity of the service will depend upon the following:

1. The grades and curves or profile of the line over which the trains must operate.
2. The weight of the train.
3. The number of stops and their location.
4. The schedule speed required.

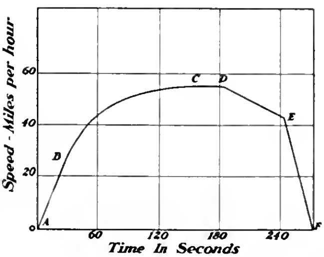


FIG. 1.—A TYPICAL SPEED TIME CURVE LENGTH, 270 SECONDS.

It is very evident that a line which has heavy grades, sharp curves, etc., will require greater capacity in electrical equipment than one of few grades. It is equally clear that the greater the train weight, the greater the capacity required for the same speeds.

The number of stops and location of these stops determine the capacity of the electrical equipment. The larger the number of stops for the same schedule speed the greater the capacity required. More time is taken up with the greater number of stops and it is necessary to operate at higher speeds between the stops, hence requiring greater horsepower in order to operate at the same schedule speed.

In the discussion of operation we often refer to the schedule speed as well as the average speed. The schedule speed is the distance in miles divided by the total time in hours, while the average running speed is the distance in miles divided by the actual running time and does not include the time taken by the stops.

The electric locomotive, in starting and hauling a train must exert a certain draw-bar-pull. This power must be applied at the rim of the driving wheels and due to the coefficient of adhesion between the wheels and the rails, the locomotive must have sufficient weight so as to eliminate slipping. The power delivered by the electric motors is transmitted through the mechanical connections to the drivers where it is called tractive effort.

Tractive effort, usually represented in terms of pounds, has a definite relation to the torque of the motor, and is determined by the mechanical connections between the motors and the drivers. These mechanical connections may be gearing, side-rods or a combination of both. Since the torque of the motor is the pull at one foot radius the formula for tractive effort is as follows:

$$\text{T.E.} = \text{lbs. torque} \times \frac{24''}{\text{D}} \times \text{ratio mechanical connections}$$

where D = drain of wheel in inches.

If gears are used the ratio of mechanical connections becomes $\frac{N}{n}$ where N = no. of teeth in the gear and n = number of teeth in pinion.

In train operation certain resistances must be overcome so that the tractive effort at the drivers is used up in overcoming these factors, which are, namely, train resistance, acceleration, grade resistance and curve resistance.

The tractive effort required to keep the train moving over a level track at a constant speed is the train resistance. Acceleration is the rate of increase in speed of the train. A certain tractive effort additional to the train resistance is required to start the train and bring it up to a uniform speed. When operating on a grade still an additional tractive effort is necessary to lift the train through the vertical distance. When curves are encountered another additional T E is required. The tendency is for the train to move in a straight line. Due to the curve, the wheel flanges press hard against the outer rail and this additional friction is termed curve resistance,

which must be overcome by additional tractive effort.

There are many empirical formulae for train resistance which agree closely with actual tests. There are cases where inaccuracies in train resistance do not affect the results appreciably, but in other cases it is necessary to have the values of train resistance used as nearly correct as possible. Take, for instance, a rapid transit multiple unit train, like in the subway, elevated on suburban service, where the stops are at close intervals, most of the total energy is consumed during acceleration so that the train resistance is a very small percentage. However, in cases of long runs, where starting is very infrequent, it is very important to use correct values for train resistance, as the energy required to overcome the train resistance becomes a very appreciable part of the total energy expended.

Train resistance can be divided into three parts, namely, journal friction, rolling friction and wind resistance. It is thus seen that it must be and is affected by the size, shape and weight of the car, locomotive or train.

As mentioned in the January issue, the operation of a train can be represented geographically by what is known as a *Speed Time Curve.* Fig. 1. The operation consists of a series of runs, the number of these runs depending on the number of stops which the train makes between the two terminals. For instance, if the terminals were twenty miles apart and there were 15 stations between the terminals, then the train operating over this division would start and stop 16 times. At each stop the train starts from standstill, increases its speed or accelerates at first rapidly and then more slowly until a balance speed is reached; the rate of acceleration depending on the grade and curve. Power is cut off when necessary and the train coasts until a point is reached where brakes are applied to bring the train to a stop at the next station. Each of these runs can be shown graphically as Fig. 1. Many times it is possible to choose a typical run. The typical run would be the average run of the above 16 runs and would represent the conditions to be met. The length of run would be the average length, and the time the average time. The grade, curve and train resistance, as well as the power required for acceleration, all enter into the problem, and determine the results obtained from the speed time curve. We should, therefore, have train resistance curves to work from and also know what values to use for grades, curves, and different rates of acceleration.

First let us consider train resistance. Curves shown by Figs. 2 and 3 are reliable and conservative. Many times quick calculations are all that are necessary and a few values are well to know or are available for handy reference so that the results can be obtained approximately without a careful check and reference to the resistance curves. These are as follows: Electric locomotives, 15 lbs. per ton and trailing load for freight

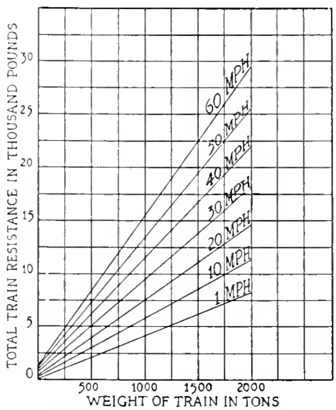


FIG. 2.—TRAIN RESISTANCE CURVES FOR TRAINS UP TO 400 TONS, AND SPEEDS UP TO 60 MILES PER HOUR.

service at 6 to 7 lbs. per ton, up to a speed of 30 m. p. h.

Having the train resistance available in the form of curves, the first part of the speed time curve to be analyzed is the acceleration. The rate of change in velocity is the acceleration. The force necessary to produce it is proportional to the pro-

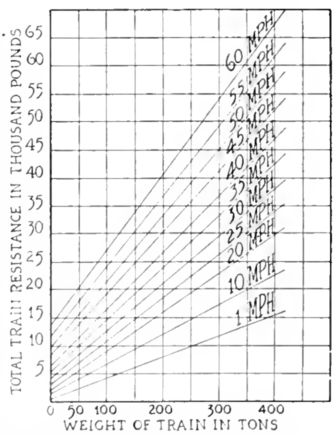


FIG. 3.—TRAIN RESISTANCE CURVES FOR TRAINS UP TO 2,000 TONS, AND SPEEDS UP TO 60 MILES PER HOUR.

duct of the mass and the rate of the acceleration, i. e.,

$$F = \frac{W \times A}{32.2} \quad \text{where}$$

W = Weight of the body in lbs.

A = Rate of acceleration in feet per hour per second.

[This value is 1.47 for 1 mile per hour per sec. accel.]

To see what this is for one ton we will use 2,000 lbs. for W and 1.47 for A and will obtain a value of 91.1 lbs. for F. While this value is the tractive effort per ton required to obtain rectilinear acceleration at the rate of 1 m. p. h. p. s., it does not take into consideration rotation of wheels, armatures, etc., so that an additional force is necessary, and to produce the 1 m. p. h. p. s. rate of acceleration a value of 100 lbs. per tons is taken. Proportional values are used for different rates; for instance, for 1½ m. p. h. p. s., 150 lbs.; for ¾ m. p. h. p. s., 75 lbs.

We have referred to the grade resistance. This is the tractive effort necessary to overcome the lifting of the car through the vertical distance. When running up a one per cent grade, the tractive effort or force required is 1/100 of the train weight. In terms of tons it is 1/100 of 2000 or 20 lbs. For any other grade, the T. E. is proportional. On a 2 per cent grade it is 40 lbs. per ton, on an 8 per cent grade it is 16 lbs.

Another resistance mentioned previously is curve resistance. Any value used for curve resistance is at best only approximate. The track, roadbed, speed of train, all enter into and affect the curve resistance.

A value of 0.8 lbs. per ton per degree is conservative and is generally used. Curve resistance may be as low as 0.4 lb. per ton with good track conditions.

To show how the values are applied to practice, the following examples have been assumed:

1. *What tractive effort will be required to propel a 300-ton train up a .65 grade at 50 miles an hour?*

Refer to Fig. 2. 300-ton train requires 4500 lbs. train resistance.

To lift up the .65 per cent grade requires 300 (ton) × (20 × .65) = 3900 lbs.

Ans. Total T.E. = 4500 + 3900 = 8400 lbs.

2. *What additional T.E. if there was a 4 degree curve on this grade?*

Assuming 0.8 lbs. per ton

T.E. = 300 × 0.8 × 4 = 960 lbs.

Ans. Total T.E. = 8400 + 960 = 9360 lbs.

3. *What tractive effort required to accelerate at 0.7 m. p. h. p. s. on above grade and curve?*

T.E. to accelerate at 0.7 m. p. h. p. s. is: 300 × 70 = 21,000, to which must be added the curve resistance, 960 lbs., and the train resistance at, say, 20 m. p. h. (2250 lbs.), or total 24,210 lbs.

From these examples it will be readily seen that if the exact amount of grade or degree of curve is known the necessary amount of added tractive effort may be easily computed with a degree of accuracy that will be found to be sufficiently reliable in any case.

The Construction of the Oxy-Acetylene Torch

By J. F. SPRINGER

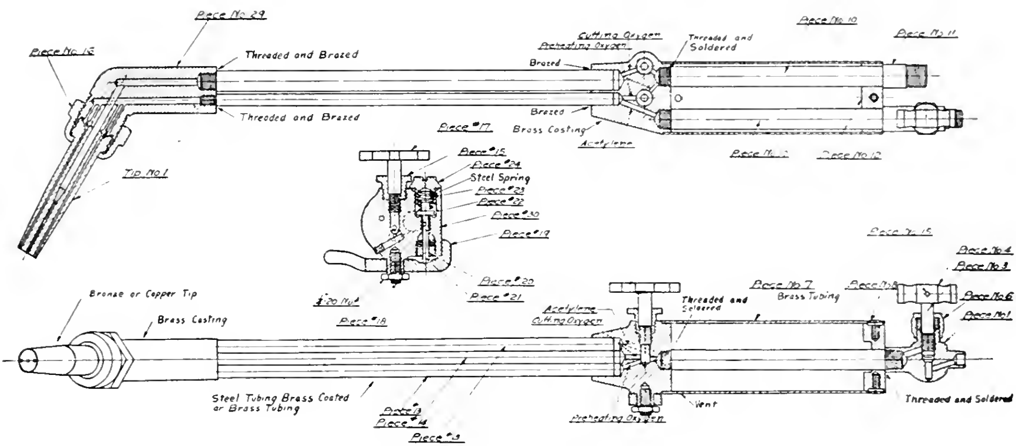
It is of importance that the user and also the prospective purchaser of an oxy-acetylene outfit should understand something of the construction features of leading commercial torches. It will, ordinarily, be best for a purchaser to secure a torch that is backed by substantial reputation and responsibility. Otherwise, he may find himself in possession of an instrument which will consume an inordinate amount of oxygen. As oxygen is an expensive gas, this condition of affairs would mean continued loss through waste. A high-class torch will consume around 25 per cent more oxygen than acetylene. There is probably nothing gained when this figure is exceeded, but something lost through waste. A torch competent to operate day in and day out below that figure is an excellent torch from the point of view of economical consumption of oxygen.

The matter of the performance of a torch may be tested in the following manner: Let standard work be carried on—that is, work requiring a neutral adjustment of the flame, which neutral condition corresponds to a sharply outlined single inner flame of brilliant white. Such work is, in general, that which consists of rolled or cast steel, iron or nickel. The consumption of both gases is to be noted by means of the indicator. The longer the period, or the sum of the divisions of the period, the better the final result. The relative amounts of oxygen and acetylene will show whether the torch is operating to high advantage.

Oxygen will ordinarily be bought and not made on the spot. It will come in steel containers and will be under high pressure. The high pressure is needed to reduce transportation costs. Acetylene may be made or not. This gas, as it enters the torch, may be under a very low pressure or else under a medium pressure. The construction of the torches differs in accordance with the use of gas under medium or low pressure; so that it is necessary to make selection to correspond.

The business of the torch is to receive the two gases, to mix them, and, without danger of a flare-back, to discharge the mixture from a tip or burner under considerable pressure. It is necessary that the mixture issue from the burner at a fairly rapid rate. Otherwise, the speed of flame transmission may be greater than the rate of forward movement of the mixture. In this case, the flame would enter the burner. This requirement that the mixture shall issue under considerable pressure means, even in the case of the use of low-pressure acetylene, that the *oxygen* shall be under considerable pressure. The prevention of a flare-back is, in part, taken care of by pressure. But this is hardly precaution enough. A favorite method of preventing a flare-back from retreating back of the torch itself, and possibly reaching the acetylene reservoir or tank, is to use a porous material as a packing in a suitable location inside the torch—or rather, torch handle—and compel the gas or gases to pass through it. Where acetylene is generated in a fixed generator at the shop, a high-class generator will probably be so arranged that a flare-back would also have to pass through water to get to the storage compartment or tank, avoiding the cause of danger.

The mixing is one of the most important functions of the torch. Upon the thoroughness of the mixing depends the economy of oxygen consumption. Let me explain. The oxy-acetylene process depends upon limiting the combustion of the carbon, derived from the explosion of the acetylene, to carbon monoxide. In order to get this result, and thus avoid combustion to carbon dioxide, the supply of oxygen is limited. The proper amount required is exactly the same as the volume of acetylene. Any oxygen over and above is really not wanted. This is understood to be the state of affairs. The reader may now ask, Why then is a greater amount of oxygen supplied than of acetylene? The reason appears to be just this: An excess of oxygen is necessary in order to make sure that every bit or particle of acetylene will have alongside or near it a corresponding bit or particle of oxygen. If the mixing could be done to perfection, then precisely the same volume of oxygen and acetylene should be supplied the torch. The excess of oxygen required by a torch is to be viewed as the measure of its imperfection in securing a complete intermingling of the two gases. There is probably no commercial torch in existence capable of perfect mixing. The thing to do then—other things being equal—is to select and use the one requiring the smallest excess of oxygen.

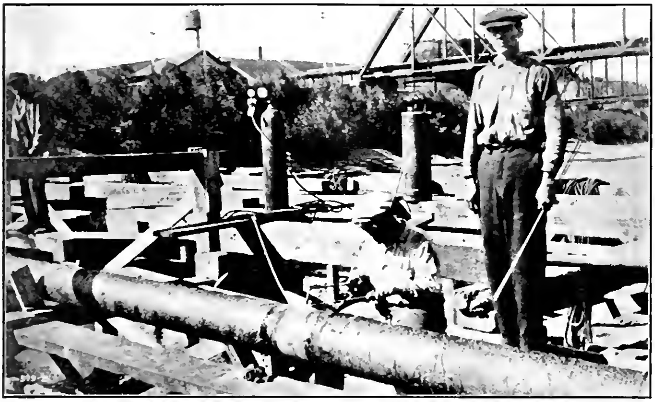


DETAILS OF ASSEMBLY OF COMBINATION TORCH.

THE TORCHES

There are two or more fairly distinct types of torch. In one, the acetylene is sucked onward by the oxygen. This is the

injector type. The oxygen will be at a higher pressure than the acetylene. In one variety of injector torch, the oxygen stream flows along the axis of the head on its way out into the air. At one point, however, the acetylene surrounds the onflowing oxygen stream and is sucked into it through little ducts. The two gases now flow onward together and mingle with each other as they flow. The part of the burner where the mixing takes place is naturally the mixing chamber.



MAKING A FINAL WELD ON 100-FOOT SECTIONS OF PIPE IN MID-STREAM.

In another variety of torch, the acetylene is understood to be under higher pressure than in the case with the injector type. In one style, the acetylene finds its way to the oxygen stream by ducts delivering it at right angles to the oxygen current. This is sometimes called the positive pressure torch.

There is at least one type of torch that provides three exits for the gases. These outlet holes are in a line and close together. The center hole emits oxygen only. The other two emit a mixture of acetylene and oxygen. These two jets are welding jets, while the central one is a cutting jet. By turning the latter off, the torch becomes an ordinary welding torch. By having it turned on, the instrument becomes a cutting torch. It is thus a two-in-one piece of apparatus.

It will be understood that the regulation of the torch is accomplished largely by regulating the inflowing oxygen and acetylene. In some styles, there is an attempt made to provide for varying the form or size of one or more of the ducts in the torch itself and thus vary the flow of the gas by adjustable means. However, some of the most prominent torches do not follow this mode of construction, but keep all ducts and passages fixed in size and form. That is, everything is fixed after the gases once pass in through the inlet cocks.

THE CUTTING TORCH

The cutting of steel by means of the oxy-acetylene process is accomplished by reinforcing the welding flame with a stream of high pressure oxygen. This does not mean the addition of another flame. Oxygen itself does not burn—it acts as the agent of burning. However, this additional jet supplies the heated steel with a large amount of oxygen. Presumably, the iron in the steel is burnt to ferrous oxide and the carbon monoxide to carbon dioxide. At any rate, the carbon seems to assist the process. In steel, the carbon is all in the form of iron carbide. There is no carbon by itself as there is in gray cast iron. For some reason, not exactly clear, steel can be cut but not cast iron. It doesn't matter in what form the steel is—cast steel, forged steel, rolled steel—the metal may be cut and cut much as if it were a piece of wood and the cutting torch a good sharp saw. A thin cut may be made and, with proper precautions, a clean and smooth one. The steel may be in orderly shape in the railroad machine shop or it may be tangled up in a wreck out on the road. It is all the same to the cutting torch. Car axles, car bodies, locomotive framework, bridge members, boilers, fireboxes, house girders, machine shop work, both new and old, and multitudes of other classes of work.

The cutting torch at first seems to have been simply a welding torch provided with a tube set just back of the burner. Through this tube the high-pressure oxygen was sent. But a number of variations have been devised. It is not necessary that there be any especial interval between the outlet of the heating burner and the outlet for the oxygen. The oxygen jet may be located in the center of the heating flame.

The oxygen stream entering the mixing chamber of the heating burner or head will have, normally, one pressure; the oxygen constituting the cutting jet will have another. But it is not necessary to have two oxygen supply tubes connected with the cutting torch. The one oxygen supply may be made sufficient. This possibility is recognized in at least one of the prominent designs. There are but two supply tubes—one for oxygen and one for acetylene. The oxygen for the heating feature of the torch is obtained from the one supply current by a proper regulation of a cock. There is, naturally, some advantage in getting rid of one of the flexible supply tubes.

The cutting appliances should in general be bought when a welding outfit is gotten. The field of application is so considerable and the additional cost so light that there will probably be but comparatively few cases where it wlll not be the wise thing to add the cutting feature. This will very often be the case, even where it is proposed to use the welding torch for non-ferrous metals. Such metals are quite often used along with steel in some form. While the cutting torch is not usable, in general, for the non-ferrous metals, it can be used to great advantage in preparing steel work both new and old. Not only may the steel be cut from stock, but it may often be roughly shaped to the desired form.

Westinghouse Extensions.

The Westinghouse Electric & Manufacturing Company contemplate erecting several new buildings including an office building, a shop for making turbine blades, and an electric generator shop, and also a building specially adapted for the construction of electric locomotives. As is well known, the company's works at Essington, or South Philadelphia Works of the company are adjacent to the Baldwin Locomotive Works, and the co-operation of these companies in construction work makes the situation particularly favorable. The Westinghouse Works at Essington have enough orders on hand at present to keep them busy the entire year without considering new business which is rapidly developing to unusual proportions.

Safety Engineering

The latest issue of *Safety Engineering* has an excellent article especially addressed to shop foremen, being an abstract of an address delivered at the first meeting of the Foremen's Safety Committee, at Harrisburg, Pa. The article is full of moving incidents, all more or less bearing upon the shortcomings of foremen who are lax in the way of giving full instructions to the workmen in all things where safety should be considered. The article is worthy of careful perusal. Copies may be had from the publishers, 80 Maiden Lane, New York City.

Items of Personal Interest

Mr. M. H. Quinn has been appointed general car foreman of the Erie lines east.

Mr. R. Romesburg has been appointed machine shop foreman of the Rock Island shops at Horton, Kans., succeeding Mr. Thomas Davis, resigned.

Mr. R. B. Freeman, formerly car foreman of the Seaboard Air Line at Monroe, N. C., has been appointed general car foreman at Hamlet, N. C.

Mr. J. B. Tynan has been appointed superintendent of the locomotive shops of the Wheeling & Lake Erie, with headquarters at Brewster, Ohio.

Mr. C. M. Freeman, formerly traveling engineer on the Sunset-Central Lines, has been appoined fuel supervisor of the Central Western regional district.

Mr. J. B. Parrish has been appointed general manager of the Chesapeake & Ohio, with office at Washington, D. C., succeeding Mr. J. P. Stevens, deceased.

Mr. G. E. Smart has been appointed general master car builder of the Canadian Northern and the Canadian Government railways, with office at Toronto, Ont.

Mr. T. F. Perkinson, formerly master mechanic of the Baltimore & Ohio, with headquarters at Baltimore, Md., has been transferred to Cumberland, Md., as master mechanic.

Mr. S. G. Strickland, federal manager of the Chicago & North Western, with headquarters at Chicago, has had his jurisdiction extended to include the Sioux City Terminal railroad.

Mr. R. D. Quickel having being relieved from military service has been reappointed fuel agent of the Southern railroad lines and associated railroads, lines west, with office at Cincinnati, Ohio.

Mr. Kenneth C. Gardner has been appointed manager of sales for the Central district of the Pressed Steel Car Company, with headquarters at Pittsburgh, Pa., succeeding Mr. Henry P. Hoffstot.

Mr. J. M. McQuaid has been appointed mechanical inspector of the Rock Island System, with office at Chicago. His duties will consist of inspection of equipment, shop and terminal facilities.

Mr. W. Jerry Stanton, sales manager of the Railway Improvement Company, has resigned from his active duties, and Mr. Eugene Schoen has been appointed general manager for the company.

Mr. Zill Pierce has been appointed master mechanic of the Saratoga and Champlain divisions of the Delaware & Hudson, with headquarters at Polonie, N. Y., succeeding Mr. A. L. Moler, resigned.

Mr. Nelson T. Burns, formerly inspector in the mechanical department of the New York Central at New York, has been appointed district salesman for the Vapor Car Heating Company, with headquarters at Chicago.

Mr. James H. Rader, formerly gang foreman of the Atchison, Topeka & Santa Fe at Emporia, Kans., has been appointed apprentice instructor at La Junta and Pueblo, Colo., with headquarters at Pueblo.

Mr. Charles W. Yeamans, assistant engineer of the Chicago & Western Indiana, has been appointed purchasing agent of that road and the Belt Railroad of Chicago, with headquarters at Dearborn Station, Chicago.

Mr. E. E. Calvin, federal manager of the Union Pacific, the Oregon Short Line, and the Los Angeles & Salt Lake, has had his jurisdiction extended over the Gilmore & Pittsburg, with headquarters at Omaha, Neb.

Mr. F. E. King, formerly carpenter on the Northern division of the Chicago, Milwaukee & St. Paul, with headquarters at Minneapolis, Minn., has been transferred to Chicago, succeeding Mr. A. Yappen, promoted.

Mr. C. A. Fisher, formerly locomotive engineer on the Spokane division of the Great Northern, has been promoted to road foreman of engines of the first district Spokane division, with headquarters at Hillyard, Wash.

Mr. S. D. Rosenfeld has been appointed sales manager of the Franklin Railway Supply Company, with offices at Houston, Tex. Mr. Rosenfeld has had a wide experience in the mechanical department of the western railroads.

Mr. W. L. Robinson, formerly supervisor of fuel consumption of the Baltimore & Ohio, Western Lines, Dayton & Union, and the Dayton Union railroad, has been appointed superintendent of fuel and locomotive performance, and his former position has been abolished.

Mr. N. Bell, formerly master mechanic of the Minnesota and Iowa divisions of the Illinois Central, with headquarters at Waterloo, Iowa, has returned from military service and has been appointed to the same position, succeeding Mr. O. A. Garber, who has been transferred to Memphis, Tenn.

Mr. C. D. Young, formerly superintendent of motive power and rolling stock of the Minneapolis & St. Louis, has been appointed superintendent of motive power of the Chicago & Alton, and the Chicago, Peoria & St. Louis, with office at Bloomington, Ill., succeeding Mr. J. E. O'Hearne, resigned.

Mr. George W. Denmore, formerly division car foreman of the Delaware & Hudson, at Carbondale, Pa., has been appointed master car builder of the road, also the Greenwich & Johnsenville, the Wilkesbarre Connecting railroad, and the Schoharie Valley railroad, with headquarters at Colonie, N. Y.

Mr. William T. Lane has been appointed district sales manager of the Franklin Railway Supply Company, with offices at San Francisco, Cal. Mr. Lane was for several years chief draftsman of the Company, and latterly, mechanical engineer, which position he held at the time of his appointment as above.

Major William L. Allison, for eighteen months in active military service has been honorably discharged from the United States Army, and has resumed his duties as vice-president of the American Arch Company. He has also been elected vice-president in charge of sales of Locomotive Feed Water Heater Company.

Mr. C. E. Chambers, superintendent of motive power of the Central of New Jersey, has been appointed mechanical assistant to Mr. Charles H. Markham, regional director of the Allegheny region of the United States Railroad Administration, with headquarters at Philadelphia, Pa., succeeding Mr. J. T. Carroll.

Hon. Percival N. Clement, governor of Vermont, in assuming office, spoke strongly in apposition to further Federal interference with railroads, telephones and telegraphs. A large share of the revenues of the State is derived from these sources, and if the Federal Government should continue to hold these properties the change would cause heavy losses to the State.

Brigadier-General Henry W Thomson, general manager of the Great Eastern Railway of England, and formerly general superintendent of the Long Island railroad, has been gazetted Knight Commander of the Order of the British Empire. General Thornton is a member of the Railway Executive Committee which operated the railways of the United Kingdom during the war.

Captain Genpe F. Daggett, who has been in military service for the past year, has been appointed chief of the Transit Bureau of the New York State Public Service Commission, first district, succeeding Mr. J. P. N. DeWitt, resigned. Captain Daggett will have supervision of transportation lines in New York City, and has had about ten years experience in the employ of the Commission.

Mr. William Gemlo, formerly master

mechanic of the Minneapolis & St. Louis at Marshalltown, Iowa, has been promoted to superintendent of motive power and rolling stock with headquarters at Minneapolis, Minn., succeeding Mr. G. W. Seidel, recently appointed superintendent of motive power of the Chicago & Alton, and the Chicago, Peoria & St. Louis, with headquarters at Bloomington, Ill.

Mr. W. C. Lincoln has been appointed engineer for the National Railway Appliance Company, New York. Mr. Lincoln has had a wide experience in special construction work in the American Locomotive Company's works at Schenectady, the General Electric Company, where he was promoted to commercial engineer in the Philadelphia district, and latterly engaged as electric engineer with the Railway Improvement Company.

WALKER D. HINES.

Mr. Walker D. Hines has been appointed by President Wilson as Director General of Railroads, and entered upon his duties on January 11. Mr. Hines is from Kentucky, and graduated from the University of Virginia in 1893. He entered railway service in the same year as assistant attorney of the Louisville & Nashville Railroad, and latterly assistant chief attorney. From 1900 to 1904 he was first vice-president of the same road. In 1906 he was appointed general counsel of the Atchison, Topeka & Santa Fe, and in 1908 chairman of the executive committee of the same road. When Mr. McAdoo was appointed Director General of Railroads, Mr. Hines was appointed Assistant Director, and has acted in full accord with Mr. McAdoo's views, including the five-year period, to which the large majority of the railroad executives are opposed.

The following have been appointed road foremen of engines on the Southern railroad lines: Mr. J. Sims at Birmingham, Ala , with jurisdiction North Birmingham, Ala., to Columbus, Miss., and Northern Alabama. Mr. J. P. Russell, Birmingham, Ala., with jurisdiction Atlanta to Birmingham, including Birmingham terminals and Lehart Creek branch. Mr. A. G. Akans, Sheffield, Ala., with jurisdiction Memphis to Chattanooga, including Sheffield terminal and branches on Memphis division.

Mr. Fred C. J. Dell has been elected Secretary of the National Railway Appliance Company. Mr. Dell has been acting Secretary during the last two years, previous to which time he was connected with the American Railway Manufacturers' Association as assistant to the Secretary-Treasurer. In 1916, he was elected Secretary of the latter association, which position he still holds. Mr. Dell began his railway career in the general manager's office of the Interborough Rapid Transit Company.

Hon. Alfred E. Smith, governor of New York, expressed his desire to reorganize the Public Service Commission of the State for the first district, New York, by reducing the number of commissioners from five to one, the one commissioner to have full authority to regulate public service. A second commissioner would undertake the duty to supervise the completion of the subways. A bill is already introduced in the legislature to carry out the proposed changes, which speak well for economy.

Felipe Pescador, acting director general of the Ferrocarriles Constitucionalistas de Mexico, announces that effective January 1, 1919, the railroads of Mexico which have been known by the name of "Constitutionalist Railways of Mexico," will be changed to their original name, "National Railways of Mexico" (Ferrocarriles Nacionales de Mexico), and will continue to be operated by the government of the Republic of Mexico in accordance with the decree issued under date of December 4, 1914.

OBITUARY.

Walter V. Turner.

Dr. Walter V. Turner, recognized as the leading air-brake expert of the present century, died at Wilkinsburg, Pa., on January 9, in the fifty-third year of his age. He was born in England in 1866 and came to America in 1888. He was manager of the Lake Ranch Cattle Company, Raton, N. M., and in 1897 Mr. Turner began railroading as a car repairer on the Santa Fe. From gang foreman he was promoted to chief inspector. Here he made a thorough study of the details of the air-brake, and was placed in charge of the air-brake instruction car; and latterly mechanical instructor for the entire system. During this period the Westinghouse Air-Brake Company purchased the rights of 22 patents secured by Mr. Turner, and in 1903 his services were loaned to the Westinghouse company. In 1907 he was appointed mechanical engineer, in 1910, chief engineer; in 1915, assistant manager, and in 1916, manager of engineering. As is well known, Dr. Turner developed the K triple valve, one of the most important improvements of our time. Over 400 patents have been granted to him, and many are still pending. He was the author of several books dealing with the development of the air-brake. He was an engaging and fluent speaker, and an able writer, many of his contributions having originally appeared in the pages of RAILWAY AND LOCOMOTIVE ENGINEERING. Dr. Turner sustained severe injuries in an automobile accident and from which he never completely recovered.

WALTER V. TURNER.

Among other complications were Bright's disease and enlargement of the heart.

George S. Hodgins.

It is with deep regret that we announce the death of Mr. George Sherwood Hodgins, a writer and editor of eminent literary and scientific attainments, and a member of the staff of RAILWAY AND LOCOMOTIVE ENGINEERING for fourteen years. He died at his home in New York on January 18, 1919, in his fifty-ninth year. A graduate of the Upper Canada College and of the School of Applied Science affiliated with the University of Toronto, he afterwards served an apprenticeship in the Kingston Locomotive Works. After some experience in a division master mechanic's office on the Canadian Pacific, he was advanced to various positions on the road, and later was locomotive inspector for the entire system. He was recalled to the Kingston Locomotive Works as mechanical engineer. Later he entered the service of the Pressed Steel Car Company

as general inspector of the output of that extensive plant, and was also for some time inspector for the Richmond Locomotive Works.

During these earlier years he had contributed to a number of railroad and scientific publications. In 1900 he entered the field of practical journalism as editor of *The Railroad Digest*. In 1902 he joined the staff of Railway and Locomotive Engineering as associate editor, and in 1908 became managing editor, which position he held till 1911, when he was called by the Canadian Government to make a comprehensive report on the shops, appliances, tools and equipment necessary for the Trans-Continental railway. On the completion of that work in 1915, Mr. Hodgins joined the staff of the Railway Periodicals Company as managing editor of the *Railway Master Mechanic*, *The Railway Engineering and Maintenance* of Way. In 1916 he returned to Railway and Locomotive Engineering and remained on the staff as editor until his death, besides contributing to popular science magazines.

GEORGE S. HODGINS.

Mr. Hodgins was the third son of J. George Hodgins, M. A., LLD., I. S. O. Deputy Minister of Education for Ontario. He married Sarah Patterson, a daughter of the Hon. C. S. Patterson, a justice of the Supreme Court of Canada, who survives him. His three brothers, Major General William E. Hodgins, C. M. G., Hon. Frank E. Hodgins Justice of the Supreme Court of Ontario, and the Rev. Frederic B. Hodgins, of New York, all survive him.

As a writer on engineering and technical subjects, Mr. Hodgins' style was marked by an exact and comprehensive lucidity. He had a mastery of detail, together with a clearness that was particularly appreciated by the young and the ambitious. He was of a genial and kindly disposition, and greatly esteemed by those who knew him best. He was a keen critic, a scholarly and accomplished editor, a delightful companion, a courteous and kindly gentleman. His spirit was illuminating and encouraging.

J. B. Keefe

Mr. J. B. Keefe, formerly division freight agent of the Lackawanna Railroad, died last month at his home in South Orange, N. J. Mr. Keefe was a native of Bradford County, Pa., and went to Scranton, Pa., in 1900. In 1912 he was appointed industrial commissioner for the railroad. He leaves a widow, a daughter of the late Mr. Charles Graham, for many years master mechanic on the Lackawanna Railroad. He was a brother-in-law of the younger Charles Graham, for a number of years master mechanic of the Lackawanna and Bloomsbury division of the Lackawanna Railroad. Mr. Keefe was fifty-five years of age.

Master Mechanics' Association.

The Executive Committee of the American Master Mechanics' Association, at a meeting held in Chicago last month, elected W. J. Tollerton, general mechanical superintendent of the Rock Island Lines, president of the association, to fill the vacancy caused by the resignation of F. H. Clark. H. F. Giles, superintendent of machinery of the Louisville & Nashville, was appointed first vice-president, and C. H. Hogan, assistant superintendent of motive power, New York Central, was appointed second vice-president. The office of third vice-president was left vacant until the annual meeting which will be held on June 23, 24 and 25, 1919.

The Railway Supply Manufacturers' Association.

A very cordial invitation is extended to manufacturers of, and dealers in railway supplies to exhibit at the Convention of this Association to be held on Young's Million Dollar Pier, Atlantic City, N. J., in conjunction with the Master Car Builders Association, June 18, 19 and 20, and the American Railway Master Mechanics Association, June 23, 24 and 25, 1919. The United States Railroad Administration has given its warm approval of holding the joint Conventions. This will be the first exhibition held in three years. The Committees are actively engaged in making complete arrangements. Details as to space and other data will be furnished on application to J. D. Conway, Secretary-Treasurer, 1841 Oliver Building, Pittsburgh, Pa.

Railroad Equipment Notes

The Boston & Maine has let the contract for a $250,000 engine house at Deerfield, Mass.

The Erie is building a 56-stall roundhouse, storehouse, shop buildings, etc., at Meadville, Pa.

The Colorado & Southern has let a contract for a coaling station and engine house at Denver, Colo.

The Canadian Car & Foundry Company has secured the site for building a car plant at St. Jerome, Que.

The Russian Government has recently renewed its orders for 4,000 freight cars formerly ordered and cancelled.

The Pere Marquette is building a machine shop 60 by 120 ft., at Detroit, Mich. Also a roundhouse at that point.

The Southern Pacific proposes to build an addition to its shops at Los Angeles, Cal. It will be 60 by 60 and two stories.

The Constitutionalist Railways of Mexico have ordered eight Mikado locomotives from the Lima Locomotive Works.

The United States Navy Department, Washington, is inquiring for four all-steel, 50-ton hopper cars, and six all-metal push cars.

The Delaware, Lackawanna & Western is preparing plans for a car shed 135 by 650 ft., to be built at its East Buffalo shops.

The Pennsylvania will expend about $100,000 on a new machine shop and equipment at Enola, Pa. The building is to be 70 by 160 ft.

The Mexican Petroleum Corporation, New York, has ordered fifty 10,000-gal. capacity tank cars from the American Car & Foundry Company.

The War Department, it is reported, will attempt to rebuild cranes purchased for its munition plants, and then dispose of them to the railroad administration.

The Erie Railroad is building a reclamation plant at Meadville, Pa. The building is to be 50 by 150 ft. This company is also erecting a tank shop at Jersey City, N. J., to cost $18,000.

The Wisconsin & Northern has awarded the general contract to Henry Boldt & Co., Appleton, Wis., for the construction of a roundhouse, machine shop and storage building for its new terminal in that city.

The Montour Railroad has acquired about 25 acres at Coraopolis, Pa., for a consideration of $65,000. A portion of the site will be used for the construction of new car shops, wheel works and other structures.

The Pennsylvania Equipment Company, 1420 Chestnut street, Philadelphia, Pa., is in the market for several second-hand, standard gage, hand operated, 30 or 40 ton capacity dump cars, with inverted V-shape floor.

The United States Railroad Administration has let contracts for 600 locomotives, 500 of which are to be built by the American Locomotive Company, and 100 by the Lima Locomotive Works. About $40,000,000 are involved in these contracts.

The Bengal-Nagpur Railways of India have bought 9,000 cars. The Indian roads have placed 5,000 underframes with the American Car & Foundry Company and the Standard Steel Car Company in the United States. The *Iron Age* says English roads have allocated 30,000 cars.

Three United States Railroad Administration Mikados, constructed for the New York Central and six constructed for the Grand Trunk West, were sent to Buffalo and four Santa Fe locomotives were shipped to Potomac Yards, Va., to be stored as parts of emergency pools.

The Pennsylvania Railroad Lines West is building a new engine house and shops at Dennison, Ohio, to cost about $250,000. It is also planning for the construction of new locomotive and car shops and new yard facilities at Wellsville, Ohio, estimated to cost in excess of $1,000,000.

Four United States Railroad Administration Mikados, constructed for the Grand Trunk, were shipped to Buffalo and five administration Mikados, constructed for the Grand Trunk, were shipped to Cleveland and four administration Santa Fe, constructed for the Southern, were shipped to Potomac Yards, Va., to be stored as parts of emergency pools.

A report has been made to the Canadian government that before the Canadian Northern, which recently was acquired as a government property, can be put into adequate condition for successful operation an expenditure of $35,000,000 must be made for tracks, bridges and roadbed. An operating deficit of $8,000,000 on Canadian government railways during the last year would be announced soon, it was said in a supplementary report.

Books, Bulletins, Catalogues, Etc.

Proceedings of the M. M. Association

The report of the proceedings of the annual meeting of the American Railway Master Mechanics' Association, held at Chicago, Ill., June 19-20, 1918. The volume extends to 528 pages, with numerous illustrations and plates. As is well known, the uncertainty incident to the continuance of the war made it necessary to follow out the principle established in 1917, in holding as brief a business meeting as was necessary to take care of the necessary business. The various committees appointed on special subjects reported as formerly and their reports form a valuable addition to the engineering literature of our time. The list of committees selected for the year ending June, 1919, and the twelve subjects on which their investigations are being devoted are furnished, together with the list of officers and members.

Fuel.

The United States Railroad Administration and the United States Fuel Administration have published in pamphlet form, extending to 56 pages, the addresses delivered at the tenth annual convention of the International Railway Fuel Association, held in Chicago last year, of which we made a condensed report in our pages. In the pamphlet the addresses are presented in full, and coming as they did from no less than fourteen of the leading experts in America it is not too much to say that the contribution to the literature on the subject is of the most valuable kind. It seemed to us at the time of the convention that every phase of the subject was touched by master hands who, through experience, had learned much that all of us who are interested should know. Copies of the pamphlet (D) may be had on application to the U. S. Railroad Administration, Washington, D. C.

Preventing Corrosion

The prevention of rusting or corrosion of iron and steel is fully described in an illustrated pamphlet of 24 pages issued by the Dearborn Chemical Company, McCormick Building, Chicago, Ill. The high reputation of the enterprising company, extending over thirty-five years, is a guarantee of the merit of the company's products. Equipped, as the company is, with one of the largest and most complete laboratories and a staff of specialists, it is not surprising that additions to their specialties are constantly being made. The publication before us refers especially to what is known as No-Ox-Id, a preventive of rust and corrosion which has proved its efficiency in positively preventing rusting or oxidization of metals, without the slightest injury to the metal itself. Other specialties are referred to and copies of the interesting pamphlet may be had on application.

Gasoline and Kerosene Carburetors

This is another new book from the pen of Victor W. Page, M. E., author of many engineering works, and published by The Norman W. Henley Publishing Company, 2 West 45th street, New York. It describes in a clear and comprehensive way the basic principles pertaining to carburetion, showing how liquid fuels are vaporized and turned into gas for operating all types of internal combustion engines intended to operate on vapors of gasoline, kerosene, benzol and alcohol. The book is divided into seven chapters. The illustrations of which these 89 are made from accurate engineering designs and show all parts of late types of carburetors. The book is invaluable to repairmen, students and motorists and is the most complete work of its kind. It extends to 320 pages, and is sold at $1.50 per copy.

Staybolts

The latest issue of the bi-monthly digest of the work of the Flannery Bolt Company, Pittsburgh, Pa., contains a comprehensive and masterly essay on the best provisions for taking care of fire box expansion. The various methods of boiler staying are discussed, and the gradual introduction of new means and methods are pointed out with a degree of historical and mechanical accuracy that shows that the writer of the article has thoroughly mastered the subject. Radial, sling stay, crown bar and crown steel staying as formerly in general use are finely illustrated, as also on boilers completely equipped with flexible staybolts. Copies may be had on application to the company's main office at Pittsburgh, Pa.

Report of the Bureau of Mines.

The eighth annual report of the Director of the Bureau of Mines for the fiscal year ending June 30, 1918, has been issued by the Government Printing Press, and consists of 124 pages of reports covering the entire field of operations in which the bureau is engaged. Like nearly all other governmental reports the effects of the war is manifested by a degree of earnestness and development of investigations, and it is especially gratifying to note that the important element of safety has received a larger degree of attention than hitherto, especially in the matter of mine explosions. The appraisal of segregated coal lands is also of special value as looking to the further development of the industry. In this latter regard the work of the Alaska station at Fairbanks is of special interest. Copies of the publication are distributed at 10 cents per copy.

Railway and Locomotive Engineering

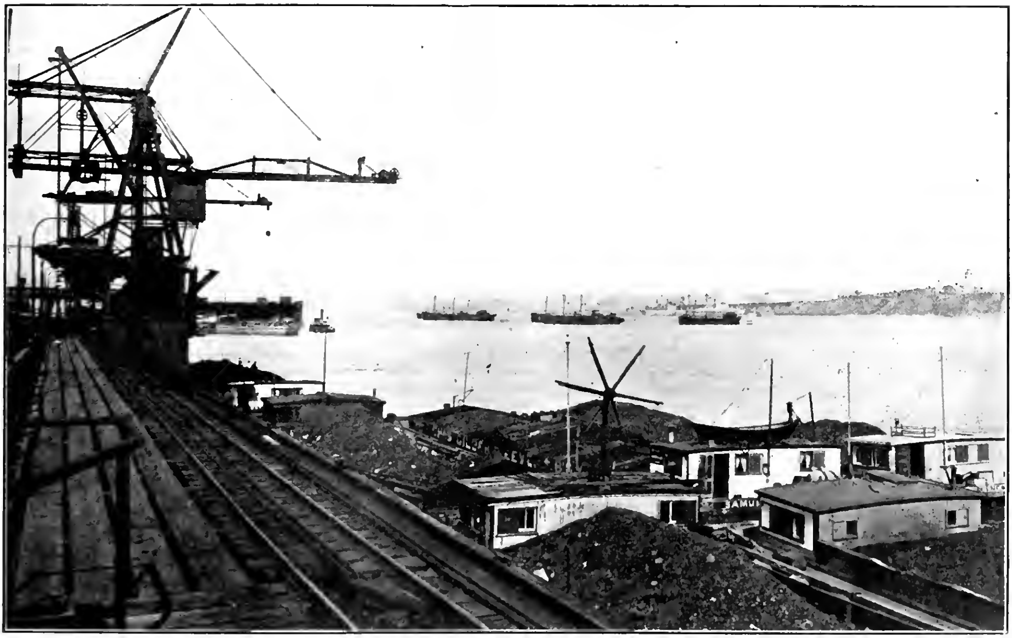
A Practical Journal of Motive Power, Rolling Stock and Appliances

Vol. XXXII | 114 Liberty Street, New York, March, 1919 | No. 3

Coal Handling Around New York and Elsewhere

Our frontispiece and accompanying illustrations show that New York is being fortified against any chance of a repetition of the coal shortage that occurred a year ago. To the most casual observer it looks as if the culm heaps that disfigure the romantic valleys of the Alleghanies were being moved to the vicinity of our imperial city. This is not to be wondered at, as the supply has increased while the mild winter has curtailed the demand. From the Government reports we learn that American miners increased the production of coal 34,000,000 tons in 1918 over that of 1917. Last year the production of 685,300,000 tons of coal was the largest in the nation's history, and it is universally recognized that this was a tremendous factor in bringing the war to a close sooner than was expected. It is also gratifying to learn that in the matter of fatal casualties from explosion of gas and coal dust there were 233 less than in 1917.

The power for the mechanical appliances used in coal handling in the vicinity of New York are furnished by the New York Edison Company. This concern furnishes electric current to the principal part of Manhattan Island. It maintains at Shady Side, N. J., on the Hudson River nearly opposite Grant's tomb, as shown in the frontispiece, a big storage yard. The coal brought from the mines by railroad is not delivered at this yard at once. It is first loaded into barges at points several miles to the south and then brought in by water to Shady Side. Here it is dug out by means of a big clam-shell bucket suspended from a trolley which runs in and out. The coal is either put in a coal pile by the clam-shell bucket or else is sent by a little cable railway to a coal pile at some distance further away from the barge. This method of digging the coal out with the clam-shell bucket,



VIEW OF COAL HANDLING APPLIANCE AT SHADY SIDE, N. J.

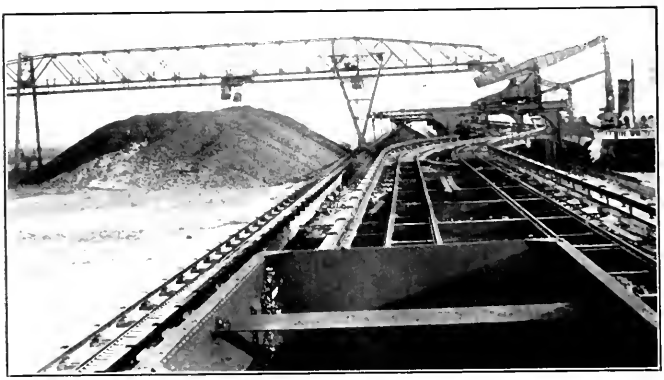
while satisfactory to the electric light company, would not suit conditions at ports where large coal laden ships come directly to the piers. These vessels bringing coal must necessarily be as quickly unloaded as possible, otherwise a considerable expense would be incurred by the consequent delay to the vessel. So an appliance is used that has been a great triumph in unloading coal and iron and other material from vessels. It consists essentially of a long arm or lever which reaches over the water and a long leg which hangs from the end of the lever down into the hold of the whaleback or other vessel. By lifting the lever the long leg is brought out, and by swinging the frame which supports the lever the leg may be swung around to any desired point. All this is important because the coal is dug out by mechanism at the bottom of the leg. The lifting out and swinging around makes it possible to discharge the coal at a variety of points. A workman housed in a cab located near the bottom of the leg remains there while the digging is going on, and regulates the action of the clam-shell buckets, and with the aid of these machines a big whaleback may be unloaded in a single day.

This latter method is shown more particularly in the third illustration and is a view of the appliances, including the stocking bridge and unloaders in use on the Canadian Pacific Railway docks at Fort William, Ontario. The methods in vogue have proved to be eminently successful, as well as at other points in Canada, and also on the Atlantic seaboard in the United States.

GENERAL VIEW FROM PALISADES, SHOWING STORAGE YARD.

There are other means and methods of coal handling, some of which we described and illustrated in RAILWAY AND LOCOMOTIVE ENGINEERING in the issue of January, 1918, but the system of conveying from ships and barges to yards, or from railway car to ships or barges, is being continually improved upon, and it seems that no situation arises that may be apparently difficult but is speedily mastered.

We would have wished to have been able to give some figures in regard to the amount of coal stored in New York and vicinity, but the statistics are not available. In our opinion, from a casual observation of the surroundings, we can unconcernedly fold our arms and bid the succeeding winters come on. The chill winds let loose from the glacial caves in the white North have no further terrors for us.



CANADIAN PACIFIC RAILWAY DOCK, FORT WILLIAM, CANADA.

Today's Railroad Problem.

In an address before the Brooklyn Chamber of Commerce delivered on February 19, among other things, Otto H. Kahn said that one year's experience had sufficed to demonstrate to the people at large that Government operation of railroads means deterioration in service, higher cost, lessened eagerness to please the shipper and study his convenience—not to mention the menace of politics becoming a determining factor in the fixing of wages, in new construction and betterments.

Every right-thinking man must wish to see railroad labor, as indeed all labor, content and liberally compensated. The first claims of labor are the first charge upon any industry. They take precedure over the claims of capital and even those of the consumer in general. An increase in wages was justly due; indeed, in many cases overdue. No doubt the committee selected by the Director General, upon the investigation and recommendation of which the action was based, did its work ably and conscientiously. The increase granted may not be more than was justly due. Its apportionment may have been fully justified. But, after all, it is the public which pays the bill, and the public had no opportunity to formulate views or make itself felt on the subject before action was taken.

The programme, in support of which public opinion is crystallizing more and more, is: Let the Government exercise strong and comprehensive control, but fair and constructive, not punitive or strangling. Let those features of operation, which under Government management have proved advantageous and convenient to the public, be preserved and those features of legislation and administration, which experience has shown to be unduly and unwisely hampering, he abolished. Without eliminating State commissions, let their functions be so adjusted as to avoid conflict with the Federal Commission in matters of rate making and security issues. Let railroading then be thrown open to private initiative and enterprise and competition in service, make it an attractive field for capital, and, above all, for men of ability and vision.

If there is one thing less desirable than outright Government operation, it is Government control so minute, hampering and all-pervasive as to be tantamount to Government operation without corresponding responsibility. Most of the plans which have been put forward from individual quarters would mean this thing. Their authors start by declaring themselves utterly opposed to Government operation, and then devise a set of provisions which, to all intents and purposes, are equivalent to Government operation, or would necessarily lead to it. A feature common to all such plans, and, in my opinion, their fatal

defect and largely the explanation of their self-contradictory character, is that they are based upon a permanent Government guarantee of minimum earnings for the railroads.

The two things, i. e., private management and permanent Government guarantee of earnings, are simply not reconcilable. The railroads cannot eat their cake and have it. You cannot rent your house to some one and then expect to be master in your house. If the railroads want to have private management in fact, instead of merely in name, they must take their chances and rely upon public opinion for a square deal. If they are not willing to do that, if they ask the people to protect them by giving them a permanent guarantee of minimum earnings, the people will rightly insist upon such minute and exacting safeguards as to amount to Government operation.

I think, indeed, that public opinion has come to recognize, not from tender regard for the railroads, but from enlightened self-interest, that the roads must be given such treatment henceforth and permitted such opportunity as will attract a free flow of capital; because, otherwise, one of two things is bound to result: stagnation in the railroad industry, which means inadequate and insufficient service for a growing and developing country, or Government ownership and operation.

If we are agreed that what we want is real private management under strict but fair, workable and constructive Government supervision and regulation, with no permanent guarantee of earnings (but rather profit-sharing with the Government and perhaps with labor), it seems to me that the framing of appropriate legislation presents no extraordinary difficulty, provided that an equitable basis of rate-making is established and defined with sufficient preciseness to enable the railroads to obtain actually, instead of merely theoretically, as heretofore, the protection of the courts against the imposition of unduly low rates.

The open-minded spirit and the conscientious and painstaking manner in which the Senate Committee is conducting the hearings on this subject are wholly admirable. In their attitude towards the problem they are, I believe, correctly representing the temper of the public which never, in my recollection, has been so predisposed for a tranquil and dispassionate consideration of the complex and difficult questions involved. All the more reason why those who by experience and study are qualified to contribute to the discussion of the problems, should express their true views with complete frankness and not make themselves sponsors for makeshift compromises. To reconcile conflicting views, to determine the weight to be attached to varying claims, is the task, not of the witness, but of the legislator.

Removing Scale from Locomotive Arch Tubes

One of the latest places in which the scale evil has made itself felt is in the clogging up of the tubes used in modern boilers for supporting the arch over the combustion chamber. This type of fire box, which is illustrated in Fig. 1, is now used by a number of prominent railroads. This baffle secures more perfect combustion of the fuel, assisting in the mixing of the products of combustion with the air that is admitted above the fire, and it also acts as a reflector of the radiant heat of the fire into the escaping gases.

On account of the enormously high temperature over the fire, unprotected metal cannot be used for supporting the brick and tile of which the baffle is composed, therefore tubes containing water are employed. These tubes are curved in the form of an arch and communicate with the water jacket of the fire box, a continuous circulation of water through them is therefore insured. In fact the locomotive arch tubes become part of the heating surface of the boiler. As these tubes are directly over the fire and at its hottest point, water is of course, evaporated in them at an enormous rate and if the water contains any scale forming material, scale is sure to collect in these tubes quicker than in any other part of the boiler. Furthermore, while a thin layer of scale might be tolerated on the flue tubes, the arch tubes have to be kept clean. Because of the enormously high temperatures here encountered any material, such as a thin layer of scale which retards the transmission of heat, is liable to result in overheating of the tubes, causing them to bag, blister and burn out.

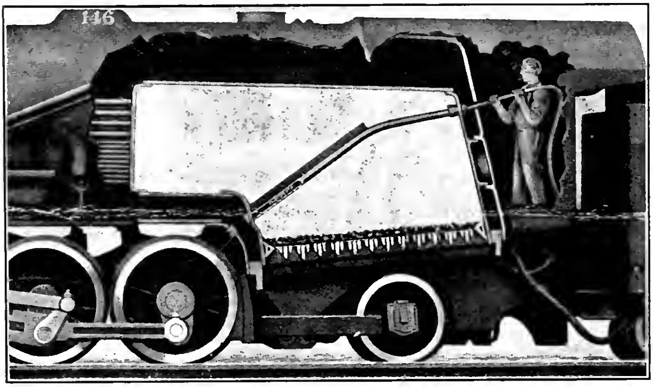


FIG. 1. SECTION OF LOCOMOTIVE BOILER SHOWING METHOD OF REMOVING SCALE FROM THE ARCH TUBES.

The ordinary type of boiler tube cleaner is not satisfactory for removing scale from these arched tubes because of their curvature. Therefore many of our readers will be interested in a special type of cleaner recently perfected by the Lagonda Mfg. Company of Springfield, Ohio. In this cleaner, the body or turbine part is exceptionally short, and the cutting head is connected to it by means of a universal coupling. The ease with which this cleaner removes scale from the arch tubes is illustrated by Fig. 1.

Fig. 2 illustrates the complete cleaner with toggle joint and equipped with a Weinland Quick Repair Head. The cleaner is driven either by compressed air or steam. Other cleaners of a similar nature are driven by water power. Complete information on this type of tube cleaner can be had by addressing the Lagonda Mfg. Company, at Springfield, Ohio. The appliance has already met with much favor

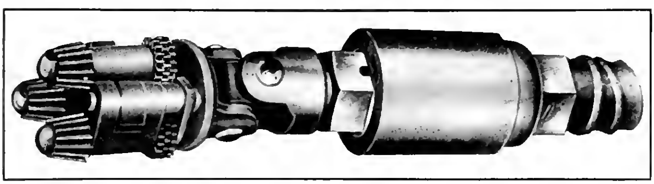
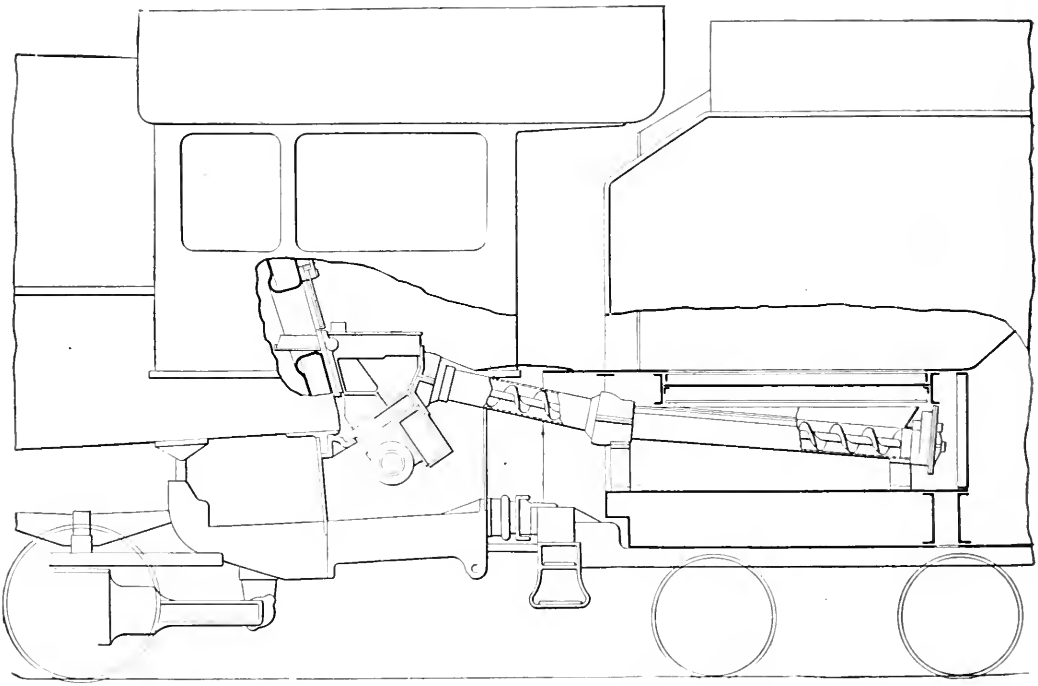


FIG. 2. LAGONDA AIR OR STEAM DRIVEN CLEANER FOR LOCOMOTIVE ARCH TUBES, MADE IN VARIOUS SIZES.

New Design of Locomotive Stoker

Summary of a Series of Tests on the Erie

A test extending over several weeks has been made on the Erie railroad, of a new design of mechanical stoker, and many eminent engineers have expressed their satisfaction with the results. It is to be expected that as the need of a mechanical stoker on locomotives grows more pressing year by year, the subject is receiving the attention of many of our cleverest inventors, and it is proper that opportunities should be given to test the merits of all that are in any way calculated to meet the requirements of the service. As is well known, the device which is known as the Elvin mechanical stoker, and operates without the use of steam jets, being a "mechanical" and not a pneumatic stoker. The locomotive equipment consists of three parts: the stoker proper, the agitator and feed control on the tender, and the screw conveyor between the engine and tender. The coal is prepared in the usual way common to the older types of stokers. The general description as furnished by the Elvin Mechanical Stoker Company, New York, and shown in the accompanying illustrations, gives in detail the assembling of a complete unit, ism, the shovels being mounted on vertical shafts, the lower ends of which carry segmental bevel gears. These gears are driven by bevel segments carried on the upper ends of a pair of centrally pivoted drive arms, the lower ends of which carry steel rollers running in the grooves of a double-faced flat cam. The cam is driven by a worm gear from the main stoker shaft and revolves in a plane approximately parallel to the usual inclination of the backhead of the boiler. Each revolution of the cam completes a cycle of shovel operation; that is, one shovel

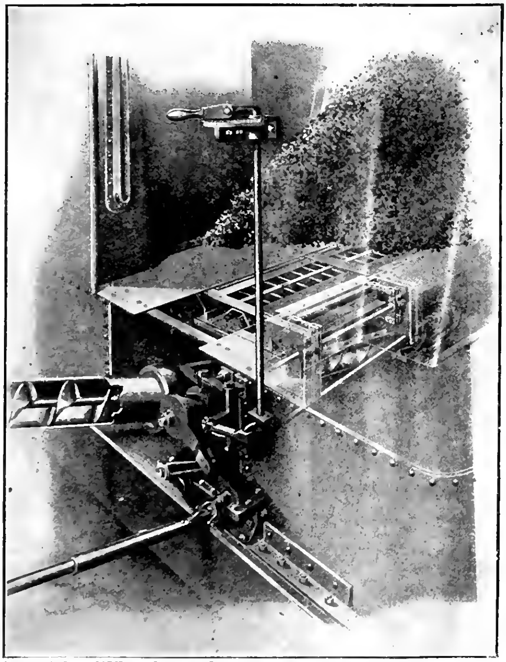


ELEVATION SHOWING THE LOCATION OF THE STOKER EQUIPMENT ON THE LOCOMOTIVE.

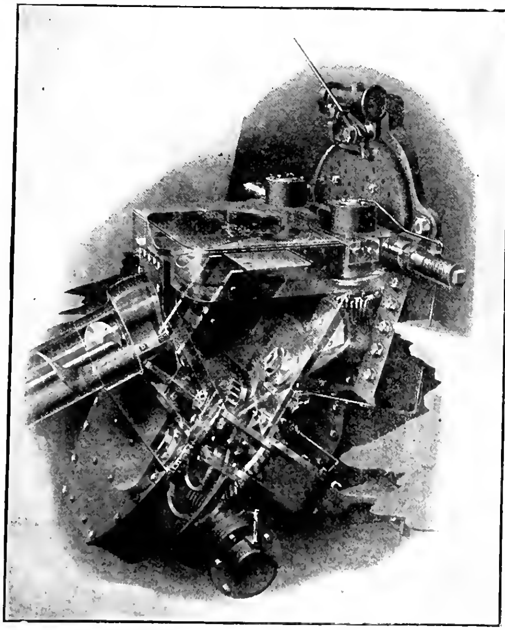
so far has appeared in two general classes, those that are so constructed that the supply of fuel is delivered above the fire, and those that supply the fuel from below, generally known as underfeed stokers. In both cases the mechanism is driven by a small steam engine on the boiler backhead. In some cases a coal crusher is placed on the tender to prepare the coal before it reaches the appliances that convey the fuel to the stoker. In others the coal is prepared before it is placed on the tender.

Coming to the new design of stoker, which is mounted on the back boiler head and braced to the mud ring by cast brackets. The proportions of the machine and its location on the backhead are shown in one of the drawings. The one design is adapted to backheads of varying slopes by the insertion of filler blocks of suitable taper between the stoker and the boiler head. The stoker consists essentially of two distributing shovels, operating through the fire door opening, and an elevator for bringing the coal from the conveyor to the level of the shovels, with a suitable driving mechan- moves around into the firebox and returns, to remain idle while the other shovel performs the same movement. Upon the cam is mounted a spur gear, which, by means of a meshing gear of one-half its diameter, drives the elevator crank shaft. The elevator is thus raised and lowered twice during each revolution of the cam, once for each of the two shovels. The elevator, which moves up and down on an inclination parallel to the cam, has an approximately level top surface measuring 7 ins. by 12 ins. In its lowest position, coal as it is delivered by

the screw conveyor, falls directly on the top of the elavator. As it moves up, a long apron extending downward from its back side forms the front wall of a V-shaped pocket, in which the coal accumulates until the elevator again returns to the lower end of its stroke. As the elevator is gear driven directly from the cam, its movement synchronizes perfectly with that of the shovels. The crank is set so that the elevator reaches the top of its stroke just as a shovel is swinging over it. A slight inclination of the top of the elevator compensates for the small amount of downward movement which has taken place before the shovel has moved completely across the top. One of the shovels thus picks up the pile back, the maximum height of which is 4½ ins. This is reduced to a height of 1¼ ins. around the end of the shovel, to permit a portion of the coal to be retained in the shovel until the end of the forward throw. As will be seen from one of the drawings, the shovels are pivoted at either side of the fire door, and are swung through an arc of about 140 deg. The use of a cam drive has made possible the attainment of the speed variations required in the course of the forward swing of the shovel to accomplish the picking up and distribution of the fuel without shock and with constant uniformity. In action, the shovel movement is uniformly accelerating until the charge of fuel has been picked up, or until the effect of distributing the fuel uniformly over the entire grate area. The distribution is capable of variation, by changes in the speed of the stoker engine; an increase in speed throws a greater amount of fuel toward the front of the firebox, while a decrease fires heavier in the rear. Irrespective of the speed of the shovels, however, a portion of the fuel is always held by the shovels to fire the back corners of the box. In practice it is found that there is a certain speed which will give the proper distribution under normal conditions, and the stoker should be operated at this speed, except when occasionally it may be advisable to fire heavier at the front or rear of the firebox. In practice the speed of firing is



PHANTOM VIEW OF THE TENDER EQUIPMENT OF THE ELVIN STOKER.



PHANTOM VIEW OF THE ELVIN STOKER ATTACHED TO THE BACK BOILER HEAD.

of coal from the top of the elevator at each stroke and carries it forward with the firebox.

The upper part of the stoker casing forms a box-shaped chamber known as the shovel box, which is covered by hinged lids. The forward end of this box is open to the firebox and the shovels swing therein. The total height of the box is 5½ ins. over the cover. The stoker thus uses the lower 5½ ins. of the firebox opening, and that part of the door opening above the stoker is closed by a butterfly door, which is used for inspection and hand firing if necessary. The shovels are L-shaped, with a flat bottom and a shovel has passed over the elevator; then the movement is rapidly accelerated until the shovel tip has entered the firebox when it is rapidly decelerated. During this deceleration, the fuel slides forward on the shovel and off the end when the back is reduced in height and at a tangent to the back of the shovel; but as the back is moving in an arc the effect is to spray the fuel throughout the remaining travel of the shovel, and that portion of the fuel held by the 1¼ ins. vane is projected parallel to the backhead when the shovel comes to a stop.

The changes in the speed of the forward movement of the shovels have the about 34 shovels per minute, or a cam speed of 17 revolutions per minute. The amount of fuel fired is independent of the shovel speed, and the distribution is not affected by the quantity.

The working parts nearly all run in ball bearings, in dust proof casings, and are in a constant bath of oil. The whole of the stoker mechanism is designed to withstand the maximum power of the engine without failure, and the engine will stall before any part of the mechanism will be unduly stressed. The stoker is operated by a reversing engine, rated at 7½ horse power at 100 lbs., pressure. The steam line to the stoker is

provided with a regulating valve which is set for 25 lbs., and is blocked for a maximum of 60 lbs.

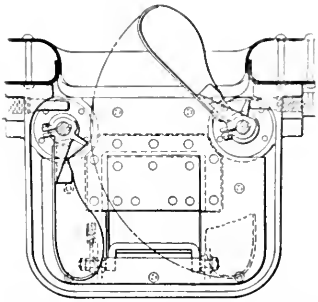
The conveyor extends from the stoker rearwardly under the coal space of the tank and is in two parts. It is supported rigidly upon the tank, and the portion between the engine and the tank is arranged to swivel to compensate for curvature and to telescope for varying lengths of coupling. The rear end of the conveyor screw is carried in a trough and between engine and tank it is carried in a pipe. The conveyor is driven from the rear through gearing enclosed in dust-proof casings. The drive is taken through worm gearing from the main stoker shaft, enclosed in the stoker casing and running in oil. A universal slip joint shaft transmits the power from the engine to the tender.

Under the floor of the tank and above the conveyor, is the feeder, which consists of an agitator, a deflector and a feeder plate. The agitator is a grating with a double row of 3⅛ ins. openings, and is operated from a rock shaft which also moves the feeder plate. The feeder plate is located under the deflector plate so that when operating full stroke the openings in the plate register fully with openings on either side of the deflector plate, first on one side and then on the other.

A simple mechanism on the rock shaft, which operates the agitator and feed plate, provides for varying the throw of the shaft and the size of the plate openings which register with the deflector plate openings, thus controlling the quantity of coal fed to the conveyor, which runs at constant speed. This device is controlled by a handle operating on a quadrant on the part of the tank, where it is readily accessible to the fireman. The range of feed varies from zero to the maximum, which is 12,000 lbs. of coal an hour.

The conveyor is designed to carry the maximum coal feed when running one-third full. This makes the movement of the fuel easy, as the action of gravity tends to roll the coal along ahead of the screw, and it reduces the danger of clogging to a minimum. The ease with which the coal is moved may be tested by turning the engine over by hand, which can easily be done with the whole device under full load.

The stoker maintains a very thin fire over a greater part of the grate area, which gradually becomes heavier toward the front, rear and sides of the box, where the heaviest fire is needed. The thin character of the fire is clearly indicated by the fact that within a very few minutes after the throttle has been closed and the stoker stopped, the only fire still burning is around the outside of the firebox, while the central portion of the grate is dead. On starting the stoker, however, the thin charges of coal immediately ignite over the entire area of the grate and a uniformly hot fire is maintained as long as the stoker continues to operate. The rapid building up of the fire and the steam pressure following the starting of the stoker, has made possible a saving in standby losses, as little need be done, either to maintain the fire or the steam pressure during detention time on the road, beyond the minimum necessary to start the train. A characteristic of the distribution of the coal which also tends toward economy is the projection of the lumps forward under the arch while the finest of the coal is retained in the shovels to be deposited in the back corners of the box furthest from the most violent action of the draft. Comparative freedom from large cinders is a noticeable feature of the operation of the locomotive equipped with this stoker.

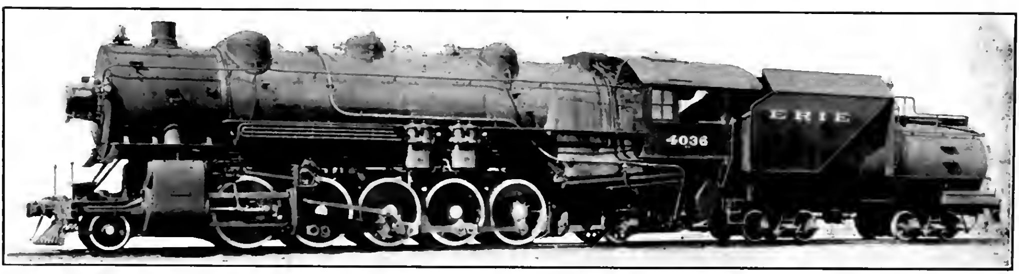


TOP VIEW OF THE STOKER WITH THE COVER REMOVED FROM THE SHOVEL BOX, SHOWING THE ELEVATOR AT THE TOP OF ITS STROKE.

The Erie locomotive, No. 4030, on which the tests were made and on which the stoker has been in regular service since October 1st, 1918, is shown in the accompanying illustration, and is of the Santa Fe type, with the following dimensions: Cylinders, 31 ins. by 32 ins.; diameter of drivers, 65 ins.; weight on drivers, 337,400 lbs.; total weight on engine loaded, 417,200 lbs.; total heating surface, 5,660 sq. ft.; superheating surface, 1,389 sq. ft.; total equivalent heating surface, 7,743.5 sq. ft.; tractive effort, 83,000 lbs.; grate area 88 sq. ft.

A series of tests was made with this locomotive, employing a dynamometer car, and accurate means for correctly determining the quantity of coal and water used. The tests were made on the second district of the Meadville division between Meadville, Pa., and Kent, Ohio, beginning in November last year, under prevailing temperature of 32 deg. Fah. This division has a ruling grade both east and westbound of one per cent, and is generally rolling in character with little to distinguish between the physical characteristics of the division east and westbound. A brief summary of the results are as follows: Length of run, 89.3 miles; time on the road, 9 hr. 50 min.; detentions, 3 hr. 50 min.; running time, decimal hr. 5.88; actual M's (1,000 lbs.) 4,243; adjusted M's, 5,133; total actual M's, including engine and tender, 4,816; average draw bar pull, lbs., 24,362; average speed in miles per hour, 15.56; average temperature of superheated steam, 693 deg. Fah.; million foot-pounds of work, 11,482; total coal as fired, running time, lb., 25,679; coal as fired to do 11,482 million foot-pounds of work, lb., 25,679; equivalent evaporation per lb. dry coal, running time, lb., 8.60; equivalent evaporation per lb. dry coal, combustible, lb., 9.59; B.t.u. per lb. of coal as fired, 13,157.

It was developed during the tests that practically perfect distribution of the fuel was obtained under all conditions. The fire was maintained at a uniform level without the necessity of using the rake or shaking the grates, notwithstanding



SANTA FE TYPE LOCOMOTIVE, ON WHICH TESTS OF NEW DESIGN OF STOKER WERE MADE.

the variable operating conditions met on this division. The engine arrived at terminals with approximately six to ten inches of fire on the grates, except a point immediately under the arch at the forward end of the firebox, where the fire was somewhat heavier.

No difficulties were encountered in cleaning the fire at terminals because of the comparative absence of clinker. The results of the tests indicate very favorable evaporation per pound of coal fired. Under ordinary circumstances locomotives of the Santa Fe type on this division require coaling and fire cleaning between terminals. During the tests, however, it was unnecessary on any of the trial trips to clean the fire on the road and the grates were operated only to relieve the accumulation of ashes. On two occasions it would have been easily possible to make a round trip without attention to the fire other than shaking the grates. This condition is in a measure attributed to the absence of moisture which is injected into the firebox with most of the other types of locomotive stokers now in use. The locomotive will handle tonnage trains over this division with the use of less than one tank of coal.

Annealing Steel.

According to a recent patent by F. Bagliard, of Milan, Italy, high-speed steel is annealed by heating it to 1,000 deg. Fahr., withdrawing it from the fire, allowing it to cool for a few seconds beneath cinders, and then immediately quenching it in water or grease, or preferably in a mixture of 200 parts of animal grease not containing stearin, 700 parts of tallow, and 100 parts of charcoal.

Changing the Lead.

In all indirect engines, that is, engines having a rocker, to increase the lead, move the larger part of the eccentric toward the crank pin the amount of increase of lead required. To decrease the amount of lead, move the eccentric away from the crank pin the amount required. On engines with a direct motion, move the eccentric in the reverse direction.

A Cinder in the Eye.

Nine persons out of every ten, with a cinder or other foreign substance in the eye, will instantly begin to rub the eye with one hand while hunting for the handkerchief with the other. They may, and sometimes do, remove the offending cinder, but more frequently they rub till the eye becomes inflamed, bind a handkerchief around the head and go to bed. This is all wrong. The better way is not to rub the eye with the cinder in at all, but rub the other eye as vigorously as you like. Try it, and be convinced.

Lubrication of Air Compressors

Means and Methods of Maintenance

An interesting paper has just been published by the Compressed Air Society, New York. It embodies the result of experiments and other reliable data compiled by H. V. Conrad, M.E., secretary of the Society, and will be found to be of value to all interested in the subject. We subjoin in condensed form some of its salient features. Regarding the formation of excessive carbon deposits, it is apt to be due to the ill-advised use of some oil, such as steam cylinder oil, which easily decomposes in the heat of the air cylinder. Oils of too great a viscosity—commonly referred to as "too heavy oils." These do not atomize readily and therefore, remain too long upon the cylinder walls, thus baking down to sticky carbon deposits. Too great quantities of oil has the same effect as too heavy an oil as far as the carbonization is concerned. The failure to provide a proper screen over the air intake of the compressor, thus allowing the entrance of dangerous matter especially coal dust.

The objections to this carbonization aside from the sticking of air valves and choking of the air passages is the menace of fire entailed by carbon deposits. Carbon particles torn loose from them may become incandescent from causes which could not be anticipated by the compressor manufacturer. If such incandescent carbon particles should happen to come in contact with "oil vapor" given off by the lubricating oil, a fire might possibly be started whose menace would be small or large depending upon how much carbon had been allowed to accumulate in the compressor and piping to the receiver. If these are kept properly cleansed at all times, there should never be a time of any danger. This oil vapor is given off from a lubricating oil at a certain temperature called its "flash point" just as steam arises from water at a certain point.

The selection of an air cylinder lubricant is, of course, governed by a knowledge of cylinder temperature it must withstand. At the end of the piston stroke, air compressed to 10 lbs. gauge pressure will have a final temperature of 145 deg. Fah.; at 40 lbs., 302 deg.; at 80 lbs., 432 deg.; at two stage or compound compression at 80 lbs., 224 deg.; at 120 lbs., 529 deg., two stage, 257 deg., at 150 lbs., 589 deg. two stage 279 deg., and at 250 lbs. gauge pressure, 749 deg., two stage a compound compression 331 deg. The intermediate temperatures may be readily calculated from the above figures, but variations from these temperatures will occur in actual practice due to water jacketed air cylinders and radiation, tending to lower the temperature at the higher pressures. But at say 50 lbs. pressure and lower, the heat is likely to be somewhat greater than given by the above calculation, particularly if the compressor is run at a high speed and also if it is not jacketed.

The natural inference is that on selecting an air cylinder oil whose flash point is higher than the maximum temperature apt to be encountered within the air cylinder. As a matter of fact, this is not the case and it need only be carefully noted that the study of the air cylinder temperatures is useful mainly on testing lubricating oils to determine their resistance against breaking down into carbon. But such temperatures cannot be taken as limits establishing the highest allowable flash point for a lubricant safe to use in the air cylinders.

For average normal conditions, the oil should be a medium bodied pure mineral oil of the highest quality, not compounded with fixed oils such as animal or vegetable, and should be carefully filtered in the final process of manufacture. Quite a range of oil composition is permissible for lubricants approved for this work, which are manufactured under the above conditions. Primarily a distinction must be made between those oils having a paraffin base as distinguished from those having an asphaltic base. From a strictly operating standpoint—so it is claimed by some lubricant manufacturers—there is no distinction between these two classes of lubricants as to their desirability as compressor cylinders oils, provided that both have been properly filtered in the process of manufacture to remove the carbon forming elements. If any carbon should be formed, however, such carbon deposited by the asphaltic base oils is of a light fluffy nature and easily cleaned out, whereas, that deposited by the paraffin base oil is very adhesive, and characterized by the hard, flinty nature.

The quantity of lubricating oil to feed to the air cylinders of compressors, cannot be stated in exact terms due to the varying viscosity of different oils, the heat of compression and the size of cylinder. It may be stated in general, however, that after the cylinders have acquired smooth and polished surfaces, the quantity should be reduced to the lowest limit to avoid the possibility of the accumulation of carbon and sooty deposits within the system due to excessive use.

The following basis of quantity is recommended for cylinder operating under normal conditions, subject, of course, to the variations of service and conditions that are changeable depending on the condition of the appliance.

QUANTITY OF AIR CYLINDER LUBRICANT REQUIRED PER 10-HOUR DAY

Diameter of cylinder, inches	Size of cylinder, inches	Displacement per minute, cubic feet	Piston speed, feet per minute	Sq. ft. of cylinder wall swept by piston	Drops oil per minute	Drops oil per 10 hrs.	Sq. ft. oiled per drop	Number pints oil required per 10 hrs.*
8	8 x 8	120	344	718	1	600	718	.0375
12	12 x 12	320	408	1,230	2	1,200	613	.0750
18	18 x 18	880	496	2,340	4	2,400	585	.1500
24	24 x 24	1,730	550	3,450	6	3,600	575	.2250
30	30 x 30	2,940	600	4,700	8	4,800	590	.3000
36	36 x 36	4,550	644	6,070	10	6,000	607	.3750
42	42 x 42	6,700	696	7,600	12	7,200	633	.4500

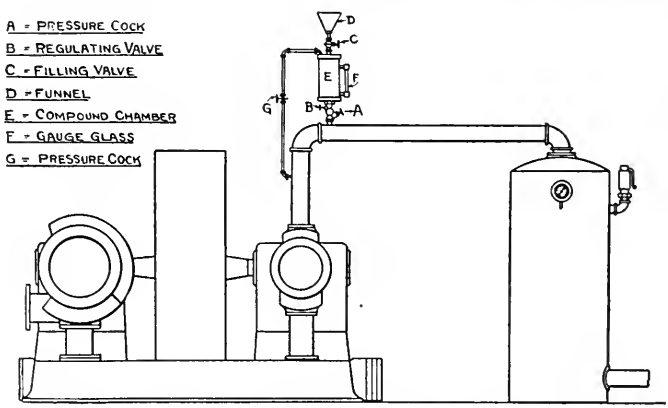
*Figures of last column are based upon an estimated 16,000 drops per pint of oil at 75 degrees Fahr.

It will, of course, be carefully noted and clearly understood that the results in the last column of the table are based upon the assumption that under average conditions of temperature and usual range of oil viscosities, a pint of oil will contain an average of about 16,000 drops. It is of course understood that these figures are offered merely as an approximate guide and that every individual must exercise his own judgment in modifying them wherever his own particular set of working conditions is unusual.

A leading authority on compressor engineering contributes the following: "The best way to determine the proper amount of lubrication is to take out the valves from time to time and examine the cylinder. All parts should feel that there is oil thereon. If they feel dry, the lubricators should be adjusted to feed a little more oil, whereas if oil lies in the cylinder and its parts show excessive oil thereon, the quantity fed by the lubricators should be reduced. By thus examining the machine a few times, the proper amount of oil can be determined to suit the characteristics of the particular lubricant used and the conditions under which the machine operates." This is a better way to finally determine the quantity of oil required than by adopting without this experimenting any tabulated number of drops.

The best of lubricating oils will cause the deposit of enough carbon in the compressor system to necessitate the periodical cleansing of it. For the removal of carbon, the machine operator should confine his efforts to the use of soap suds. A good cleansing solution is made of one part soft soap to fifteen parts water. These suds should take the place of oil for a few hours, and be fed into the air cylinders about once a week, either by means of a hand pump or through the regular lubricator at a rate about ten times as rapidly as that of the oil. The cleanliness of the air valves when inspected, as they should be periodically, will indicate whether greater or lesser applications of the soap suds should be made. After using soap suds, open the drain cock of the air receiver, and of the intercooler in the case of compound machines, to draw off any accumulated liquid. Oil should be used again for a half hour before shutting down the machine in order to prevent rusting the cylinder and its fittings. Never use kerosene, gasoline or lighter oils in an air cylinder for any purpose whatever, because of their volatile nature under heated conditions.

It often happens that oil, carbon and other foreign matters are deposited in the air discharge lines and air receiver. A practical method of cleaning these is shown in cut attached, where a receptacle made of 6-inch pipe is shown set on top of the discharge pipe. The cut shows plainly the construction and what the different parts represent. If a mixtur of one pound of Red Seal Lye and eighteen pounds of water is passed into the discharge line at the rate of 60 or 70 drops per minute, while the compressor is running, this will eat out all the accumulation on the surface of the pipe and in the receiver, and if the blow-off valve on receiver is open, all of this foreign matter will be discharged therefrom. This cleaning solution can be used every month or two or depending on how much accumulation there may be in the receiver.



DETAILS OF DEVICE FOR CLEANING CARBON IN AIR DISCHARGE LINE AND RECEIVER OF AIR COMPRESSORS.

The proper quantity of oil to be fed to steam cylinder is much greater than to air cylinders due to the constant washing away of the oil by the steam. Approximately four times as much oil will be needed in the steam cylinders as in those for air, subject, of course, to variable local conditions. Depending on its viscosity, a pint of steam cylinder oil will furnish from 5,000 to 8,000 drops, and taking an average of about 6,500 drops, and four times as much oil as air cylinders of same size, and working at same piston speeds, the recommended amounts to feed the steam cylinders or their equivalents are given in the following

QUANTITY OF OIL FOR STEAM CYLINDER LUBRICATION.

No. Drops Per Minute.	Size of Cylinder, Inches.	Number Pints Oil Required Per 10 Hours.
4	8 x 8	.4
8	12 x 12	.75
16	18 x 18	1.5
24	24 x 24	2.25
32	30 x 30	3.0
40	36 x 36	3.75
48	42 x 42	4.5

These figures are approximate only, and will vary with the steam conditions, the kind of oil used, and its method of introduction into the steam, also with the boiler compound carried by the steam into the cylinder.

When the operator of an air compressor succeeds in obtaining lubricating oils that are giving satisfactory results, he should be very cautious about making a change to other grades, particularly if cheapening the cost is advocated by purchasing and sales agents. But if a change is decided on, the performance of the new lubricants should be most carefully checked up before damage can occur to the rubbing surfaces of the compressor, and to see that no increased amount of deposit collects on the inside walls of the air receiver. Reliance may be put on the foregoing statements.

The Preservation of Railway Ties

It is a well-known fact that the question of the future supply of timber for railway ties has, for a decade or more, been a serious one in the United States owing to the rapid depletion of the forests, and within the past five years the anxiety has also spread in Canada. At a meeting of the Canadian Railway Club held recently H. K. Wickstead, of the Canadian Northern Railway, read an interesting paper on the subject, from which we subjoin some condensed extracts. Among other matters, it was shown that seasoning timber increases its strength by as much as 80 to 100 per cent in some cases over that of the green stick. It will be seen at once that, consistently with reasonable expense and loss of time, it is well worth while to dry not only ties, but timber of any kind used as a beam or strut, where strength is necessary. If we increase the strength by even 60 per cent, we require only 62 per cent of the amount of material, and, as this percentage is dry, while the other contains a very large amount of moisture, the saving in freight is very much more than the apparent 38 per cent. In Eastern Canada, at any rate, transportation is a very large item in the cost of our timber and is compelling us, as a matter of expediency, to use steel and concrete where we should use timber if it were readily available.

It being granted that drying or seasoning is extremely desirable, the question is as to the means. In the case of ordinary lumber, air-drying supplemented by a few hours in a kiln is fairly satisfactory. In that of dimension timber it is not so. In that case the air-drying of large timber takes years to accomplish, because the temperatures used in the ordinary kiln are so high as to injure the strength of the timber; and even when carried on with the greatest care and deliberation, the outside laminæ dry first before the heart of the stick has any chance, and this shrinkage causes checks and cracks which for many purposes render the stick useless.

In experiments with warm vapor, that is, warm air saturated with moisture, and circulated among the ties, it has the effect of cleaning the pores of the wood. The liquid components of the saps and resins filling the vesicles themselves, expand with the heat and force their way out, to be diluted and carried away by the warm vapor. After some hours of this treatment, the amount of moisture is reduced by very slow degrees, until, at the end, it is practically dry and the timber is removed with not more than 5 per cent of moisture left in it. The rapidity with which this is done depends upon the size of the sticks and the nature of the timber, just as it does in other methods, but no subject has yet been found which did not, in the end, yield to treatment. Care is taken not to let the temperature of the kiln get above 160 degrees F. so that no injury may be done to the fiber of the wood. Timber so treated is said to be indestructible, except by fire, so long as it is kept dry. Even without further treatment it will undoubtedly long outlast unseasoned material. It is, in this shape, in pre-eminently good condition to receive creosote, but creosote is absolutely unnecessary and that the elements of decay being altogether removed from the inside, all that is necessary is to keep them from entering from the outside. Some waterproofing coating is desirable, and in the case of ties a cheap one is the only one which can be economically used. In the experiments so far conducted a heavy oil tar was found which answered the purpose perfectly, and which is an almost worthless by-product of the refineries. The ties are merely dipped in a hot bath of this material for a few minutes and, on coming out, are sanded by a sand blast to absorb any superfluous stickiness and make them easier to handle, just in the same way as an asphalt road is sanded. Timber for building, where neat joints and carpentry are required, would probably be better treated with some pigment mixed with oil or varnish, but for rough work the asphalt or mineral tar seem to be all-sufficient and very inexpensive. The estimated cost of the drying process is 7 to 8 cents; of the protective coating three or four cents a tie. Taking the higher figures and adding a margin, it would appear that 15 cents will cover the total cost.

The prospect which is opened up by this process is something more than merely getting the equivalent of the process-creosoted tie at a less cost. It is, besides, the potentiality of using for ties timbers which are now useless for the purpose, or nearly so. The northern birch, for instance, is a strong reliable wood, used by the Indians for every purpose requiring a hard wood, but unavailable for ties or bridge timber on account of its superabundant sap and its consequent tendency to rot rapidly. The poplar and the balsam are others for which there is at present practically no demand. These timbers are particularly interesting to us just now on account of the recent opening up by the railways of thousands of square miles of northern forests, of which, with spruce and jack pine, these are the main constituents. The use of these woods for commercial purposes means not only millions of dollars to the railways in reduced cost of ties and in freight, but more millions to the people of Canada who have been burning up and wasting this forest growth as something not only worthless, but as actually impeding settlement.

As a result of our experiments with these ties we concluded that they were in the right direction in the main, but that the asphaltic waterproofings were imperfect. They melted and ran under a strong hot sun; and when abraded, as was inevitable in the case of ties, the waterproofing was gone. Some of the more tarry products which penetrated the grain of the wood were much better, and we believe them to be very good indeed.

Except for the expense, creosoting after the seasoning process has been carried out would be perfect; but we are extremely doubtful of the efficacy of creosoting for an unseasoned stick of timber. It always seem to us like putting a coat of paint or varnish on green wood. This merely closes up the outside pores of the wood and prevents the evaporation and oxidation of the juices and saps of the interior.

Creosoting costs now some 40 cents per tie, so that the treated tie costs us considerably over $1 and is heavier and harder to handle than the untreated tie. One of the advantages claimed for the seasoning is that it very greatly reduces the weight instead of increasing it, and that as a result we have less to pay for transportation and for trackwork. The seasoning can be accomplished in a month or less (the time varies with the character of the timber) so that even if we resort to creosoting we save time and interest on money invested in green ties, and we save room in our piling yard and dry sheds.

Waterproof Glue

Two good recipes for making glue are as follows: To 0.5 pint of the best Scotch glue add 1 oz. bichromate of potash. This glue cannot be remelted after cooling. The second recipe is to melt and mix together 1 part beeswax and 2 parts rosin. Stir into this hot whiting rubbed fine until a stiff mixture is obtained. This is made into sticks and used like sealng wax.

Stopping Leaks in Coal Cars.

A novel method of stopping up a hole in the side of a steel car is to plug the opening with a quantity of hay or straw. This makeshift makes the car quite satisfactory for use and serves to postpone indefinitely the delay and expense which would have occurred, had the car been sent to a shop for repairs. It is becoming a common practice in the mining regions in America.

The Care of Locomotive Steam Gauges

It is well to be reminded of the Federal regulations that have been in operation for several years, and are being constantly added to, not only in regard to the inspection and testing of locomotive boilers, but the boiler attachments, or boiler mountings as they are generally called. Among these the steam gauge needs attention especially during winter. It will be borne in mind that the safe working pressure for each locomotive boiler is fixed by the chief mechanical officer, or by a competent mechanical engineer under his supervision, based upon the thickness of the boiler plates and general construction, and the factor of safety regarding such construction. The same may be said of the regulations regarding the inspection of the boiler. In regard to the steam gauges, every boiler should have at least one gauge which will correctly indicate the working pressure. Care must be taken to locate the gauge so that it will be kept reasonably cool, and can be conveniently read by the engine men. Every gauge should have a siphon of ample capacity to prevent steam entering the gauge. The pipe connection should enter the boiler direct, and should be maintained steam-tight between boiler and gauge.

It is not necessary at this time to present a history of the development of the steam gauge from the earlier and cruder forms of the instrument. Suffice it to say that it has reached a degree of perfection that is eminently satisfactory. The manufacturers, particularly in New England, have excelled in this as in other of the smaller devices and appliances and the Crosby Steam Gauge and Valve Company, as well as the Ashton Valve Company, have placed on the market steam gauges that have stood the test of time, and have met the requirements of the constantly increasing degrees of pressure and vicissitudes of service admirably. Other manufacturers also furnish excellent products, and it is not so much with a view of advancing the interests of certain constructors of gauges as to call attention to the need of a proper maintenance of the device in whatever form it may appear. They all need watching.

As we have already stated this is particularly the case in winter, when the occasional freezing of the condensed steam in the steam gauge itself or in the pipe leading to the gauge is not uncommon, and while the safety valves may be very reliable in the matter of blowing off at, or nearly at, the right pressure, a freezing of the steam gauge or its connections has a pernicious effect on the delicate mechanism of the gauge. Even under the best conditions and with incessant watchfulness the steam gauge is a delicate instrument and subject to erratic changes. Its errors, when they exist, are, however, nearly always on the side of safety. The steam guage usually indicates a higher pressure than that which is in the boiler. The particular form of construction, as well as the location of the gauge, has much to do with its baffling eccentricities. If the internal mechanism or motive power of the gauge is of the horse-shoe or bent-pipe variety, commonly called the Bourdon tube, the expansion of which, when under pressure, moves the pointer on the dial, errors should not be unexpected on their records.

The old practice of testing the steam gauge by cold water pressure is gradually being improved upon. As is well known a metal that is subjected to any unusual degree of heat is not as rigid as it was when under normal temperature. It may therefore be understood that if a bent pipe will straighten out to some extent when a pressure of cold water is applied, it will straighten out still further when the water is at a boiling heat, and a high pressure of steam, having a corresponding greater degree of heat, the metal becomes more elastic the greater the heat. The variation is slight by actual measurement, but the variation has a tendency to increase and hence the necessity for repeatedly testing the gauge. In some well managed roundhouses the steam gauge is tested at each period of boiler washing.

It should also be noted that the variations will likely increase in the case of steam gauges that are set in close proximity to the heated boiler. Pieces of wood set under the gauge stand give a double advantage in lessening the degree of heat reaching the gauge, as well as deadening the incidental vibration unavoidable to locomotive running.

It should also be borne in mind that it is not good practice to make repeated changes in the adjustment of the safety valves to suit the more flexible, and hence more erratic steam gauge. The safety valve springs are substantially constructed and are much less likely to be in error than the steam gauge. The opening of the safety valves at a slight variation from the point originally adjusted to suit the gauge is a matter of little consequence. If the safety valves are occasionally readjusted to suit the steam gauge the chances are very great that the locomotive will lose in power and efficiency, and a repeated testing of the gauge by some fixed standard is better than a constant meddling with the safety valves themselves.

The length of the connecting pipe between the boiler and the steam gauge is an important factor in the equable working of the gauge. A long, bent pipe soon becomes filled with water which, being exposed to the open air, will be much cooler than if a short pipe was used, and therefore less likely to add to the vagaries of the indications. The connecting pipe should also be connected directly to the boiler. When connected to turret heads as was very frequently the older practice, or fountains where the injector valves or other attachments are also supplied the current of steam may be, to some extent, temporarily diverted from the steam gauge, and superinduce the errors to which the gauge is liable.

Considerable improvement has been made in recent years in the material of steam gauges, some manufacturers cleverly brazing steel and brass together in such form as to act as a kind of thermostat, the one metal acting upon the other in such a way that they nullify undue expansion up to a certain point. These improved gauges, of which there are several kinds, where set sufficiently far away from the boiler remain nearly correct for a long time, and probably approach as near perfection as can be expected from so delicate an instrument which must necessarily continue to be subjected to incessant variable degrees of temperature.

Tempering Track Chisels.

Put the chisel in the forge and heat it, then draw it out and finish it just as you want it. Put it back in the fire and let it stay five minutes without blowing and let it stay until it has a cherry red heat, then bring it out on the anvil and pour water on the anvil, and get a smooth-faced hammer. Strike lightly on the smooth side of the chisel until it quits frying the water. Dress it off with a file two inches, then put it back in the forge and heat it to a cherry red two and a half inches. Have some warm water and cool one and a half inches. Wait until it becomes a light straw color and then cool one-half inch. Rub in the ground until it is bright and let it come to a bright blue, and cool off. If the chisel is made of good steel it will stand.

Drilling.

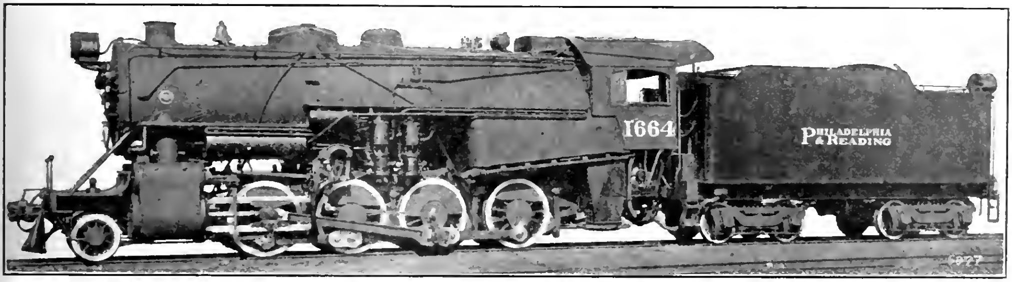
When drilling, reaming, rosebitting or tapping holes in wrought iron or steel, always use oil or some other good lubricant. For cast iron or brass do not use any kind of lubricant.

I will not pray that each time I shall build both strong and true; but imperfect, I will pray for impulse that I may build anew.—Elbert Hubbard.

Consolidation Type Locomotive for the Philadelphia and Reading Railroad

The Philadelphia & Reading is now receiving, from the Baldwin Locomotive Works, a consignment of Consolidation type locomotives which are notable because of their weight and hauling capacity. It is interesting, in this connection, to compare their leading dimensions with those of the first Baldwin Consolidations built for this company. Such a comparison is as follows:

Date	Cylinders	Drivers, Diam.	Steam Pressure	Grate Area	Water Heating Surface	Superheating Surface	Weight on Drivers	Weight, Total Engine	Tractive Force
1880	20 ins. x 24 ins.	50 ins.	120	76	1357	...	90,000	104,000	19,600
1918	25 ins. x 32 ins.	55½ ins.	200	94.9	2655	575	250,800	281,100	61,260



CONSOLIDATION LOCOMOTIVE FOR THE PHILADELPHIA AND READING RAILROAD.
Baldwin Locomotive Works, Builders.

The locomotives built in 1880 had boilers of the Wootten type, equipped for burning fine anthracite; and this same type of boiler in somewhat modified form and of greatly enlarged dimensions is used in the new design. The fuel generally used today consists of a mixture of fine anthracite and bituminous coal, and this is burned on a rocking grate, instead of on a combination of water tubes and pull-out bars, as applied to the earlier locomotives.

The new locomotives are designed for heavy drag service, and are in many respects similar to a group of Mikado type locomotives, which preceded them. In consideration of the kind of fuel used, however, and the relatively small diameter of the wheels, a firebox of sufficient depth can be placed above the rear drivers without raising the boiler center to an excessive height; and the necessary steaming capacity can thus be obtained without the use of a rear truck. In the new Consolidations the boiler center is placed 9 ft. 7½ ins. above the rail.

The boiler has a conical ring in the middle of the barrel, which increases the diameter from 79¼ ins. at the first ring to 85⅝ ins. at the throat. The firebox has a combustion chamber 39 ins. long, and a brick wall 26 ins. high is built across the throat of the chamber. Flexible bolts are used almost exclusively in the water legs, and four rows of expansion stays support the front of the crown. The firebox has two oval fire-door openings, and the doors are power operated. A standard stoker is applied. The mud ring is single riveted, except at the corners, where it is increased in depth to take two rows of rivets. A four-hopper ashpan is applied, the two rear hoppers being back of the wheels and outside the frames. The equipment includes a power grate shaker.

The smokebox is comparatively short, and is equipped with the "Economy" front end arrangement, as patented by Mr. I. A. Seiders, Superintendent of Motive Power and Rolling Equipment of the Reading. A special feature of this arrangement is a "breaker plate," which consists of a slotted plate fitted with deflecting vanes. This plate is placed under the superheater damper and in front of the tubes, and is very effective in breaking up the large sparks before they strike the netting. The netting frames are most substantial in construction, and the device has proved most effective in preventing the setting of fires due to escaping sparks.

The cylinders are cast separate from the saddle, the right and left-hand cylinders being interchangeable. They are made without bushings, and have barrel walls 2¼ ins. thick. The cylinder castings and central saddle are made with suitable recesses through which the frames pass. The frame at this point has a single section, 5 ins. wide by 13 ins. deep, and the cylinder, frame and saddle are held together on each side by a total of 59 horizontal bolts, 1⅛ ins. in diameter. The saddle and cylinders are keyed to the frames at the front by vertical keys. The valve motions are of the Walschaerts type, and are controlled by the Ragonnet power reverse gear.

The frames are of most substantial construction. They have a depth of 7½ ins. above the pedestals, and the pedestal binders are held in place by three bolts in each end. The main pedestal wedges are self-adjusting. Strong transverse braces of cast steel are applied to the frames between adjacent pairs of driving-wheels. The brace back of the main drivers supports sliding bearings, which carry the front end of the mud ring. The rear end is supported by an expansion plate.

The cab, in accordance with the most recent practice for Wootten boiler locomotives on this road, is placed at the rear end instead of over the middle of the barrel. The sides of the cab are cut away in front in order to permit easy access to the staybolts.

Further particulars are as follows:

Gauge, 4 ft. 8½ ins.; Cylinders, 25 ins. by 32 ins.; valves, piston, 13 ins. diam. Boiler, type, Wootten, conical; diameter, 79¼ ins.; thickness of sheets, 13/16 ins.; working pressure 200 lbs.; Fuel, hard and soft coal mixed; staying, Radial. Firebox, material, steel; length, 126¼ ins.; width, 108¼ ins.; depth, front, 78½ ins.; depth, back, 56½ ins.; thickness of sheets, sides, ⅜ ins.; thickness of sheets, back, ⅜ ins.; thickness of sheets, crown, ⅜ ins.; thickness of sheets, tube, ⅝ ins. Water space, front, 5 ins.; sides 4 ins.; back, 4 ins. Tubes, diameter, 5⅜ ins. and 2 ins.; material, 5⅜ ins., steel; 2 ins., iron; thick-

ness, 5⅛ ins., No. 9 W. G.; 2 ins., No. 11 W. G; number, 5⅜ ins., 36; 2 ins., 239; length, 13 ft. 6 ins. Heating surface, firebox, 225 sq. ft.; combustion chamber, 71 sq. ft.; tubes, 2,359 sq. ft.; total, 2,655 sq. ft.; superheater, 575 sq. ft.; grate area, 94.9 sq. ft. Driving wheels, diameter, outside, 55½ ins.; diameter, center, 49 ins.; journals, 11 ins. by 13 ins. Engine truck wheels, diameter, 33 ins.; journals, 7 ins. by 11 ins. Wheel base, driving, 17 ft.; rigid, 17 ft.; total engine, 27 ft.; total, engine and tender, 63 ft. 11 ins. Weight, on driving wheels, 250,800 lbs.; on truck, 30,300 lbs.; total, engine, 281,100 lbs.; total, engine and tender, about 462,000 lbs. Tender, wheels, number, 8; wheels, diameter, 36 ins.; journals, 6 ins. by 11 ins.; tank capacity, 9,500 U. S. gals.; fuel capacity, 15 tons; service, freight.

Operations on French Railways.

Major I. A. Miller, of the staff of General W. W. Atterbury, formerly Vice-President of the Pennsylvania railroad, says that French railroad methods are quite different from those in America. While the French locomotives are large enough and modern, their cars are not only of low capacity but are also light in construction. They are generally of four-wheel design with no trucks, no air-brakes, only a brake bar on the side of the car, which when pushed down by hand, applies the brakes in the same manner as the brake on a wagon.

They follow the hump yard classification in many of their large yards, only there are no brakemen to ride the cars, Men stand along the tracks, and when the cars approach they place a chock, somewhat like a brake shoe, on the rail head, and when the wheels strike this it is pushed ahead of the wheels and the friction on the rail checks the car. If this does not stop the car sufficiently, the brake bar is dropped on the side of the car.

In France railroad traffic runs to the left, although all traffic on the streets, tram cars and subways run to the right. Passenger service is quite efficient, although at the present time it is greatly curtailed because of war and the necessity of using carriages for hauling troops. They absolutely limit the amount of passenger traffic by declining to run more than a certain number of trains per day, or to provide more than a certain number of coaches. Military traffic is always given the preference, and the general public is obliged to wait if facilities are inadequate.

Passenger stations generally are dark and dingy, with no facilities for comfort, and are quite a marked contrast to the modern stations which the American traveling public has demanded during recent years.

Inspection and Maintenance of Car Equipment.

Referring to the inspection and maintenance of car equipment, J. J. Tatum, general supervisor of car repairs, United States Administration, states that the protection of millions of passengers using the railroads of our country, as well as railroad employees, and the protection of billions of dollars' worth of railroad property and billions of dollars of freight hauled in cars operating over our railroads, depends upon the thorough and careful inspection made to railroad cars of our country by our inspectors. There also depends upon their careful inspection and repairs to equipment, the protection of our foodstuffs to feed our good people, numbering more than a hundred millions, as well as hundreds of millions of people in Europe. With this great responsibility upon the inspectors, their value and the necessity of them being able to make proper inspection and repairs, cannot be discounted.

To bring about these desired conditions, it is necessary that we first select for the heads of our car department men who have been thoroughly trained and well experienced. They should see to it that inspectors selected are capable of making safe and proper inspection of car equipment. This can only be established by requiring inspectors to pass such examination, as the head of the car department has prepared to be suitable, and that will insure the inspectors, after once passing the examination, being capable of performing the work assigned them.

They should also see that inspectors are given all trains to inspect and permitted to hold them until inspection is made. Cars once inspected and passed as being O. K. and fit for service, should be in such condition, that when inspected again at next inspection point, they will not be shopped out for defects that existed at time of previous inspection; neither should they fail while in movement, due to such defects. In other words, should an inspector inspect and pass a car as being safe and fit for loading at St. Louis, such car should be in condition to continue through to New York or any destination without being shopped out or breaking down in movement due to defects existing when car was inspected at St. Louis.

When a car repaired on shop tracks at Chicago is moved to New York for loading, it should not be necessary to shop it for defects that existed when placed on shop tracks or for improper repairs made at Chicago, on or before its arrival at New York

As no car should be permitted placed for loading until first inspected and given needed repairs; unless we are able to obtain these desirable conditions, our inspection or our repairs are not uniform, or our supervisors are not capable and efficient, or some one is removing shop cards or causing cars to leave inspection points or repair yards before they are in proper condition for service.

Unless such conditions are corrected (if they exist) we cannot expect to establish the unified requirements which would result in safe and economic operation. To have unified inspection and repairs to equipment we will have economic and safe operation, which will mean to our railroads: Less loss of life and limb of passengers and trainmen, greater car mileage, fewer accidents, less destruction of equipment and property, less repeated shopping of cars, greater car supply, less need for purchase of new equipment, decrease in cost of operation, less maintenance cost, prompt handling of business, greater satisfaction to shippers, better earnings for railroads and a more satisfactory dividend for the stockholders.

Railways in Siberia

The development of Siberia has been retarded owing to the fact that there is only one main line of railway. The absence of branch lines has hindered the full utilization of the great natural resources of Siberia, and the population have had great difficulty in shipping their products to profitable markets.

Up to the outbreak of the war the main line of the Trans-Siberian Railway provided the only means for handling the traffic of Siberia. This was supplemented in summer by steamboat services on the principal rivers, which flow north and south and are intersected by the railway. Settlement has therefore been confined for the most part to the narrow strip of territory adjoining the railway and the banks of the rivers. Long before the war leading Siberian public men and organizations were urging the construction of branch railway lines, not only to create a wider market for the agricultural products of the country, but also to render possible the further exploitation of the mineral and forest resources of Siberia.

The most pressing need of the present moment, however, is the restoration of the existing railway facilities to working efficiency by repairing the roadbed and providing sufficient rolling stock to enable the Trans-Siberian Railway to transport the goods urgently required in the interior of the country. The lack of railway cars and locomotives is one of the chief obstacles to the relief of the present economic situation in Siberia, and their provision demands first attention.

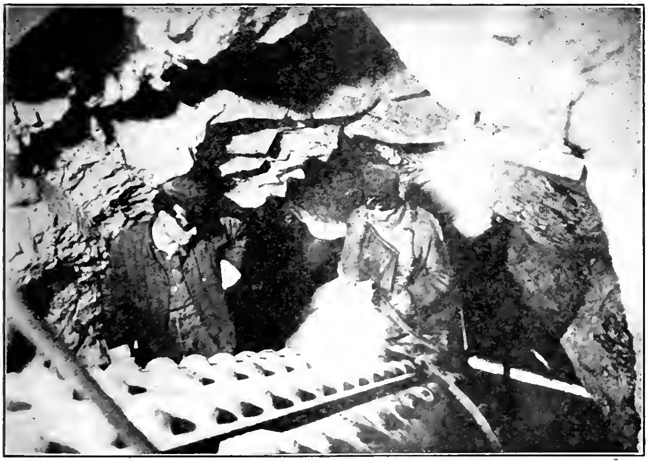
Reducing Friction in Threading.

When cutting threads on brass rods or pipes, the dies have a tendency to squeak. A solution of very strong soap suds applied to the metal will reduce the noise as well as the friction.

Operating and Adjusting the Welding Torch

By J. F. SPRINGER

The railroad shopmen will use the oxy-acetylene process in two ways: (1) In welding various metals, and (2) in cutting steel. As railroad equipment is constructed of very many diverse metals it is important that the railroad welding operator shall not confine his study of the subject to iron and steel. Doubtless, these are the metals he will be occupied with during 90 per cent. of his time. Nevertheless, how about the remaining 10 per cent.? Brass, copper, aluminum, bronze, tin, zinc, etc., are metals widely used and attracting further attention as civilization advances. It will not do for the railroad welding operator not to be informed as to what can be done with such materials. Ability to adjust and re-adjust his torch correctly is a part of the game and must be mastered, if he is to become a real expert.



VIEW OF WELDING A JOINT AT ENTRANCE TO TUNNEL.

Because the oxy-acetylene welding torch is used for various metals, it becomes necessary to adjust the flames to suit the varying conditions. The adjustment suitable to steel may not be at all the proper thing for copper. One of the gases issuing from the burner is oxygen. In addition, the acetylene breaks up and streams of hydrogen and gaseous carbon result. In making any adjustments, we are limited, in point of fact to two streams—one for the oxygen and one for the acetylene. We cannot regulate the hydrogen and the carbon independently of each other. When going into and through the torch, they are bound up together in the acetylene. They do break apart just after leaving the torch, but they are then beyond our power to regulate. In short, then, it is possible to adjust the flow of oxygen without disturbing the stream of acetylene; and it is possible to adjust the flow of acetylene without disturbing the flow of the oxygen. Here our regulations begin and end. However, we may get three types of flame. (1) By adjusting the oxygen and acetylene so that they just about counteract each other and no substantial extra amount of either is left to act by itself on the highly-heated metal. This is the *neutral flame.* (2) By varying the conditions producing the neutral flame in such way as to have an excess of oxygen left over, an *oxidizing flame* is produced. The extra oxygen, it is to be expected, will attack the hot work. (3) Finally, by changing the adjustments so as to have an excess of carbon, a *carbonizing flame* is created.

Suppose, for example, that the oxygen and acetylene cocks have been adjusted so as to produce a neutral flame. The oxidizing flame may readily be produced by increasing the oxygen flow or decreasing the acetylene flow. Similarly, with the torch adjusted for a neutral flame, a carbonizing flame will be produced by opening the acetylene cock further or by closing the oxygen cock to a further point.

A neutral flame is, ordinarily, the thing for steel. A carbonizing flame would tend to inject carbon into the steel when it is highly heated. The effect of this may be injurious. Carbonizing will probably begin while the steel is still red or before it assumes an orange, and may be expected to continue indefinitely as the temperature goes up. The effect of more carbon is to increase the hardness and decrease the pliability. On the other hand, if steel is welded with an oxidizing flame, a cutting action is produced. These considerations are especially to be borne in mind by those using the torch in railroad shops and elsewhere where steel is concerned.

In welding copper and copper alloys high in copper, it is so important to prevent an excess of oxygen in the flame that it is probably the best practice to use a flame that has a carbonizing character.

It will be understood from the foregoing remarks that adjustment counts for something. Fortunately it is quite possible to judge accurately when the flame is adjusted neutral. The neutral flame may thus be readily made the basis for securing a carbonizing or an oxidizing flame. When the neutral condition exists, the little white flame close up to the burner will be a brilliant white and will be sharply defined. These are good and sufficient tests of the neutral conditions. They are very easily noted. One has merely to be on the watch. If the flame loses whiteness or sharpness of outline, the neutral condition has probably been lost. *This may occur during work.* The operator may start out with his adjustments perfect. Later, because of some change in pressure with either the oxygen or the acetylene or some variation in the quality of either, the neutral condition passes away. It is readily restored by simply manipulating the cocks until whiteness and sharpness reappear.

The torch may be started and the neutral flame produced in the following way: The acetylene cock is partly opened, the oxygen cock being left closed. The weak stream of acetylene is lighted. The oxygen *regulator*, back of the torch, is now set at the proper pressure and the oxygen cock on the torch opened up full. Usually, the condition now will be a flame containing a great excess of oxygen. An oxidizing flame may often be recognized by the appearance of a violet color in place of the white of a normal inner cone. The acetylene cock is now opened, not too suddenly, until *two* inner white flames appear. This condition indicates an excess of acetylene. If the double white flame fails to appear by the time the acetylene cock is fully opened up, the oxygen cock may be shut off until the double cone is seen. As this state of affairs means an excess of acetylene, all

that is now necessary is to shut off the acetylene cock gradually, watching the white flame. A moment will come, if the torch, etc., are what they should be, when the two white flames will merge and a single sharply defined one stand out. It should be a brilliant white. An exactly neutral adjustment has now been secured. It has taken some time to explain what to do and the meanings of one or two things, but the actual carrying out of the directions will, with a little practice, soon be done in rapid fashion.

The high temperature credited to the oxy-acetylene flame (about 5,500 degrees F.) does not exist any and everywhere over the flame. The large transparent envelope extending from and surrounding the little white flame has a comparatively low temperature. The excessively high temperature probably exists nowhere else than in a very small region at the outer end of the little white cone or perhaps a trifle beyond this end. In fact, the excessively high temperature is possible, only because a large part of the total heat produced by the torch is concentrated in a small region. Absence of such high concentration is probably the reason why the oxy-hydrogen flame has a maximum temperature very much lower than the hot spot of the oxy-acetylene flame. The little white flame is, in fact, the working part of the oxy-acetylene operator's instrument. The special requirements of different metals, etc., may make it advisable to do the heating at points varying through a small range. Generally, for steel, the working point will be at or very close to the outer end of the sharply designed white cone of the neutral flame. For copper, the working point will be further out from the tip of the burner.

It is important that the operator should master the matter of adjustments. As already indicated, readjustments may become necessary during the progress of the work as well as at the start. The operator *must* be on the watch for fluctuations in the character of his flame and should then quickly readjust. Perhaps the best general directions here are: (1) to get the double cone by increasing the acetylene flow or decreasing the oxygen one, and then (2) to reduce gradually the acetylene to produce the neutral flame. Having once gotten the neutral condition, it will only be necessary to hold it or else make the variation necessary for the particular work in hand. These directions are for quick readjustments during operations. I have already explained how to start up. It is one of the operator's chief businesses to watch his flame.

There are two things which the working flame has to do: (1) It has to heat the surface of the work to or near the melting point, and (2) it has to melt the welding rod. The torch will be in one hand, the rod in the other. With some metals, as copper, the melted metal in the groove where the weld is being made and the welding rod are both to be kept free from contact with the inner cone, as such contact is productive of damage. With other metals, as cast iron, this contact will have no such serious effect. It is probably best, however, in the general run of cases not to get any metal actually into the white cone. The reason turns on the contents of this white flame. It is understood that, in this region, three gases are flowing alongside of one another, each uncombined with either of the others. That is, we have currents of free hydrogen, free gaseous carbon and free oxygen. Free oxygen is probably bad for pretty much all metals when the latter are in a highly heated state. Carbon is likewise, in general, undesirable. Hydrogen will sometimes be injurious, sometimes harmless. Thus, with nickel, the hydrogen would have no ill effects.

Some remarks on the sizes of welding burners will be in order. The size of the burner, other things being equal, determines the *power* of the torch. With a big burner, one will get, naturally, a big flame with which to pour into metal a large amount of heat. With a small burner, one naturally gets an instrument of less power. The character of the metal and the thickness and width of the weld play important parts in determining the size of the burner. In the case of one or two makes of burner, more than one size of burner may be used with the same torch. It is not difficult to understand the desirability of varying the power of the flame—that is, the size of the working cone—for various conditions. Aluminum, magnesium, tin, etc., have low melting points and do not require extraordinary amounts of heat. With thin work of such metals, a small size of burner should ordinarily be employed. Steel calls for a medium size. Copper is an example of a metal requiring a generous size of flame, if effective use is to be made of the torch and of the operator's time. It is to the manufacturer's interest to name the proper size of burner for various classes of work. It will be advisable, if the manufacturing concern is one of repute, to accept the maker's statements on this point.

The Life of a British Locomotive.

Sir J. Aspinall, in his presidential address at the Institution of Civil Engineers, said that "assuming that the line of railway does not vary, and that the seven types will do all the work, the question of maintaining those types for a long period of years—always assuming that they have been thoroughly well designed —depends on the march of progress; and if you look back over a series of years you will find that each period of, say, 10 years on some lines, and 15 years on others, calls for great changes in the locomotives brought about by changes in traffic conditions, when it becomes necessary to break away from tradition and to enlarge and improve the machine as a whole, while retaining the maximum possible number of interchangeable parts. If we take the period of 10 years, and assume that the life of the locomotives will be 30 years, it is obvious that after the tenth year, if such changes as I have indicated come about, we shall be adding to our number of classes, and may even have to add to our number of types, and that before the actual death-rate of the first lot, due at the thirtieth year, really begins, we may have 21 different classes or types on the same railway at the same time. The casual observer might consider that there was too great a variation, whereas the user would be easily able to show that progress has demanded the change, and that economy of operation and capacity for earning have been increased by the modernization of the plant. The change, therefore, becomes a subject for consideration, and not for superficial criticism. The form of the locomotive, as distinguished from its original detailed parts, may last for 30 years."

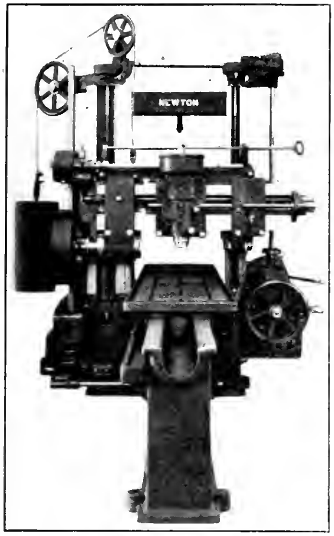
Heavier Steel Rails.

A home contemporary calls attention to the fact that railway practice in prewar times showed a tendency to increase the weight of rails. This tendency has been accentuated by the heavy traffic and great increase in wheel-loads, due to the war conditions of the last four years. In the United States in the last twelve months many of the railroads have gone to sections considerably over 100 lbs. per yard. One of them is now contemplating the adoption of a 200 lbs. steel rail. The railroads employing sections in excess of 100 lbs. report greatly reduced cost of track maintenance and a reduction in the number of failures, as well as a better running track. Experiments with heat-treated rails have shown results indicating that they also may have a future. Apparently there are no reliable means of knowing with certainty when the limit may be reached.

Metal Polish

In a quart of gasoline mix eight ounces of whiting, taking care that the whiting is free from hard particles. Shake up this whiting thoroughly and add thirty-two drops of oleic acid. It will be observed that the whiting does not settle to the bottom of the receptacle, but remains in solution. Apply to any kind of metallic surface with a piece of cotton flannel, rubbing well. Polish with a piece of the same cloth perfectly dry.

New Type of Keyseat Milling Machine



END VIEW OF HORIZONTAL MILLING MACHINE.

Our illustrations show the new type of heavy duty horizontal Keyseat milling machine, manufactured by the Newton Machine Tool Works, Philadelphia, Pa. Among its new features is a set of Newton centers with quartering devices for accurately milling on the quarter the keyseats of locomotive axles so that both ends of the axle may be finished with the original setting. A vertical spindle is another new feature used to end keyseats when necessary, such as those in the eccentric strap bearings. Still another feature is that a cutter can be mounted on the horizontal spindle to allow milling keyseats in multiple.

This machine is particularly adapted for long shafts, the table being supported its full length, and the base and table can be made to mill any desired length, such as may be required for large rotors. The table of the machine has nine changes of gear feed from a box in which are mounted adjustable sleeves, giving changes without removal of gears. The table has also reversing fast power traverse. The cross rail is counterweighted, and also has reversing vertical fast power traverse in addition to hand adjustment.

An important feature in the shaft transmitting motion for the vertical adjustment of the cross rail is in being fitted with a micrometer collar for adjusting the cutter on the horizontal spindle to the required depth. The horizontal spindle is driven by a bronze worm wheel and hardened steel worm, fitted with roller thrust bearings. The vertical spindle is driven by a worm wheel and spiral bronze gear, and the drive for both spindles is encased to permit of continuous lubrication. The horizontal and vertical spindles are both fitted with a No. 4 Morse taper.

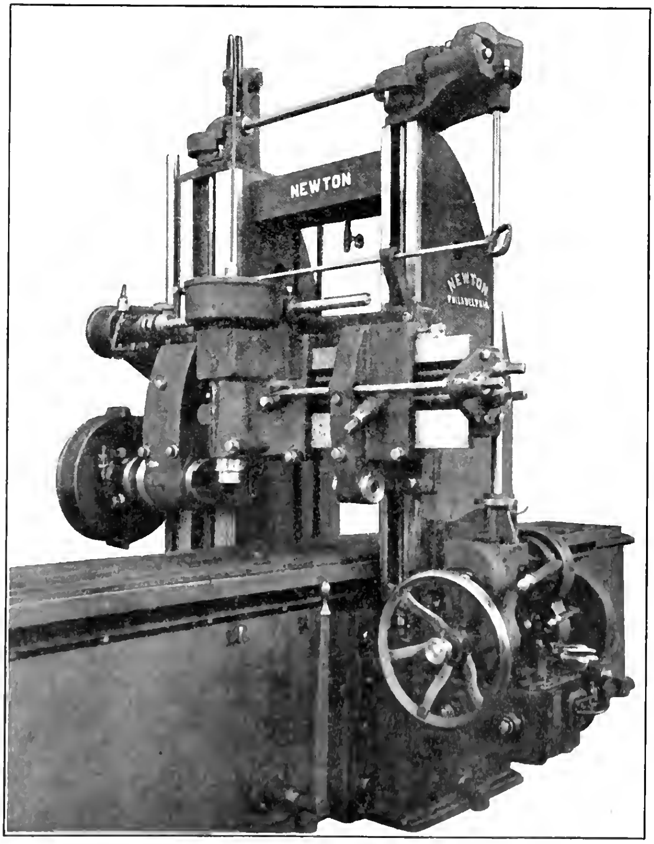
The work table has three finished T slots, drilled stop pin holes at each end, and is surrounded by a pan for draining off the lubricant to a tank in the base. It is operated by a spiral pinion and angular rack. The outer support on the cross rail is adjustable on the rail by means of a rack and pinion. The cross rail elevating screws have a top and bottom bearing to insure their operation in tension.

It will be observed that all of the controls, of which there are six, are concentrated and brought within convenient reach of the operator. It may be added that every bearing except those for the lifting screws are bushed. The gears are steel or bronze, except the large substantial gear.

The general dimensions of the machine are as follows:

Diameter of horizontal spindle in bearing, $4\frac{3}{8}$ ins.; diameter of horizontal spindle through driving gear, 4 ins.; side adjustment of horizontal spindle by hand, 4 ins.; distance center of horizontal spindle to under side of cross rail, $2\frac{1}{2}$ ins.; maximum cutter swing on horizontal spindle, where vertical spindle saddle does not interfere, 10 ins.; maximum cutter swing under vertical spindle saddle, 6 ins.; width of work table over working surface, 20 ins.; length of table to mill, 10 ft.; width between uprights, 26 ins.; maximum height center of horizontal spindle to top of work table, 33 ins.; maximum height end of vertical spindle to top of work table, 35 ins.

The weight of the machine, complete, is 22,000 lbs. when length of table to mill is 10 ft.



SIDE VIEW OF HORIZONTAL KEYSEAT MILLING MACHINE.

Railway and Locomotive Engineering

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JAMES KENNEDY, Managing Editor.

J. SNOWDEN BELL, Associate Editor.

A. J. MANSON, Associate Editor.

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The Convention Idea.

Seeing that we are having all of the usual railroad conventions in 1919, it is well to think what a convention amounts to, and what it really was. Railroad men have spent time in preparing papers and discussions for their association meetings, as well as in arranging their railroad work so that they may be absent. The supply men have spent time and money, not only in preparing their exhibits, but in research and experiments, and service tests that have developed the devices they exhibit, and by calling in their sales force to attend the convention, and explain details of the appliances.

All this effort must be considered an investment, and we must look to the results to determine its value. The results we look for are the spreading of information from railroad man to railroad man, from supply man to railroad man, and from railroad man to supply man. In every one of these cases the value of the information secured will depend to a great extent on the time and care spent in its preparation.

Before our readers do go to a convention, they should study the list of exhibitors at the convention, and make notes of the subjects that are of greatest interest to them. Then when they arrive they may arrange a systematic plan for viewing the exhibits in which they are interested, with the least possible lost motion or lost time.

It is worth while to avoid the busiest hours, as salesmen then are likely to have their attention diverted to such an extent that much time is lost. It is worth while to make a preliminary survey of the booth, from the aisle, and determine as far as possible the most interesting features of the exhibit, before taking them up in detail one by one. It is worth while to have a note book very handy, and it is no reflection on any man that he is unable to remember and assimilate the vast amount of information offered him during a convention. It is worth while to waste as little time as possible in getting over the features of a device to the limit of your present knowledge, or to where you can begin to gather facts that will extend your information; it wastes both your time and a salesman's time for you to listen to facts with which you are already familiar. It is worth while to get what descriptive matter you can, and to wait until you are back from the convention to read it over, with your notes on that subject, to get the best possible grasp of the subject. It is worth while to make a note or get a card from the man you talk with, for any questions that may come up later can be profitably referred to him, with the knowledge that he can tell how far the subject is clear to you.

There are two extreme courses to be avoided, in studying the exhibits; first, to treat each exhibit as equally important to the next, and so devote no more time to the subjects in your own special field than you do to subjects of little except general interest to you. The second is to confine all of your attention to your own field, and not take advantage of the exceptional facilities offered to familiarize yourself in a general way with the advances made in related fields of work.

Between these two lies the proper course, and every man will have to hold himself responsible for the most advantageous distribution of his time. It is not out of place to suggest that when the booths you are most interested in are crowded, you cannot fare worse in booths of less specific interest to you, for all the information wanted from them can often be secured from the aisle, whether the booth is crowded or not. Mornings are the best time for the concentrated work in your own department, as every exhibit will be set in order, and more freedom is possible in comparing devices than later, when the attendance increases.

The subject of how best to make the convention serve you and through you, your work and your railroad is worth painstaking study. All the thinking and planning that can be done beforehand will result not only in more time available for the purposes of a convention, but in a more advantageous use of time.

The Effects of High Water in Locomotive Boilers.

In regard to the effect of high water in locomotive boilers it may be said generaly that it is of a pernicious kind. This is more particularly true in the case of boilers equipped with superheating appliances. The higher the degree of superheat the better the results will be. In the case of carrying high water in the boiler, the superheating apparatus will help to evaporate the water, but it cannot accomplish this and raise the temperature of the steam at the same time. With high water the superheater merely becomes an auxiliary in the evaporation of water. The water must necessarily be turned into steam before the steam can be superheated, and in the case of water being carried into the dry pipe and so reaching the superheater pipes, the water present in the steam must first be converted into steam, and the action of the superheating appliance is largely diverted from its real purpose.

This is not the only detriment in the case of carrying high water, but just as a boiler accumulates scale from impurities in the water, so does the superheater units collect the sediment until it hardens and becomes thick enough to insulate the steam that is passing through the pipes so that they are prevented from absorbing the necessary heat, and consequently the performance of the locomotive will show a diminution in effectiveness.

It will thus be seen that the water should always be carried as low as the conditions will permit, particularly in superheater locomotives. Hostlers and others who may have charge of boilers in roundhouses and terminals should be instructed that flooding the boiler is bad practice. In addition to destroying the efficiency of the superheater it also induces leaky units, rendering increased repairs, and in short reducing the increased benefit to be derived from the appliance to a negligible quantity.

The Ethics of the Derail.

The derail is still in use on many railways, but it is not impossible to believe that one day it will be no more. There are two reasons which may be given for this; one of them is purely ethical and the other is more or less financial. These two are very potent factors, and must surely influence the view of railroad men whenever the use of the derail comes up for discussion. It is ordinarily placed at interlocking points, where two railways cross one another's tracks on the level. It is also to be found at the entrance of swing or lift bridges. The object of the derail is to put engine and cars off the track if they are driven past a point where an absolute stop is imperative.

The object is to make derailment the price of disobedience, and one might almost think that its use implied a challenge to the effectiveness of discipline on the road, though this is, perhaps, too severe a view to take. Cases could be multiplied where in the derailment of the train innocent people have suffered with the guilty. As a case in point, an occurrence that happened some years ago on one of our large railways may be cited. A passenger train of five cars, with engine and tender, were "put on the ties" at an interlocked "diamond" crossing because the engine-man overran the home signal, which was against him, although no train was in sight on the other railway. The baggageman, the express messenger and others, shaken up, when the train went down a 6-ft. embankment, were heard to describe the derail as a barbarous appliance, since they were not guilty and no actual safety had been secured for the train.

It is true that mechanical appliances cannot discriminate between what is decidedly hazardous and what is simply a breach of rule, and there are many who think that this method of automatically disciplining the man on the engine has in it enough that is unfair to others to restrict or modify its use. The engineman is not necessarily to blame; the train may be beyond his immediate control, but a stop must be made, come what may. When the purely ethical view is taken, the derail does not have the argument all on its side.

The financial reason is that a derailed train is almost sure to be more or less damaged, and the cars and engine have to be put on the track, which costs money, and the damage repaired at a price. An example may here suffice. A yard engine of the consolidation type, new from the repair shop, with much too little weight on the pony truck, evinced a tendency to mount the rails, even on the easy diverging track at switches. A zealous official, oppressed with the idea that time was money, and not being familiar with derailed engines, put this engine on the track several times, before he was made to desist. His trouble lay in the fact that the engine, when on the ties, was so hastily and clumsily got on the rails that, in the language of the roundhouse, a "good engine on the ties was turned into a scrap heap on the rails." So much had been broken in the process of re-railment.

The parallel between the yard engine and the derailed train holds sufficiently well to point out the factor of expense which usually makes its appearance in such cases. The advent of stop signals and the use of electricity has done much to reduce the necessity for the derail. No one will argue that the saving of life can for a moment be weighed in the balance against a shaking up of passengers and the "consequential damage," to be paid for. Better a thousand times to retain the derail on every railway in the country than to lose a human life; but time has wrought improvements, and the way is looked for and is being found, to produce the same safe results by other and as effective means.

The Return of the Soldiers and the Railroads.

We are meeting every day gallant young soldiers returning from battle, mostly asking our advice in regard to what is the most likely department in railroad operations offering opportunities of advancement to earnest workers. We wish that we were able to point out the clear path to each individual seeker after light, but the task is an impossible one. It largely depends on the individual. Those whose youth has been spent without some experience in manual labor would find that firing a locomotive is a laborious occupation requiring more than ordinary physical strength and activity. Those who have reached manhood without any experience in machine shops would find much difficulty in getting an opportunity of entering for an apprenticeship in any of the mechanical departments, and still more difficulty in securing sufficient compensation to meet living expenses in these days of high prices while learning the particular trade which they had chosen.

A large number of the youths of all nations spend some years in ineffectual beginnings at occupations. The knowledge that they gain in this way is not altogether wasted, but it is better if the mind of the young man had been directed toward some particular branch in a department of human endeavor. Nature never errs. Her followers are wise. Lightly built lads who may be good in penmanship and clever in mathematics should not waste their time in sighing for the opportunity to move throttle levers, they should learn stenography, and to that add the correct use of words, and they will find a wide and growing field in several departments of railroad work.

Before the war, railroading, like many other occupations, was overcrowded, but the future is full of promise. This is especially true of the expanding opportunities of the west and southwest. New roads have been projected and delayed again and again, but they cannot be delayed much longer. There will be a call for young men in those golden fields of opportunity. The strong, the accomplished, the self reliant will be welcomed.

It is pleasing to observe that the principal railroads are making room for the returned soldiers who, previous to their enrollment in the army, were engaged in the railroad service. This is as it should be, although the problem is a serious one. In the shortage of labor incident to the call to arms, the influx of new workers, including many thousands of women, were drawn into the service. The great bulk of these have been found worthy and capable, and it should not be expected that these employees are to be indiscriminately dismissed. The new regulations in regard to the general adoption of the eight hour law creates a demand for an increase in the number of employees, and it may be relied on that no difficulty will arise in the future, but will be met and overcome by that spirit of mutual interest that has become intensified by reason of the titanic struggle through which the spirit of the American people has come so triumphantly.

It is also well to bear in mind, that, as might be expected, the added transportation that taxed the utmost capacity of the railroads, has since the cessation of hostilities fallen off considerably. The reduction in the number of passenger trains, the increase in rates and other causes has had its effect on what may be called the traveling public. It will likely be some time before this resumes its normal activity. Meanwhile the Railroad Administration is acting strangely in reducing purchases of railway supplies to a minimum. This is already working serious hardship upon the companies manufacturing such supplies, with the result that many are contemplating the prospect of not only reducing the number of employees, but of shutting down their plants and thus adding to the number unemployed. It seems to us that it would have been wiser to have taken the opportunity to rehabilitate the equipment, as it is well known that a large amount of deferred maintenance has accumulated as a consequence of the railroads being run for years with a minimum amount of new equipment. But the underlying motives of the ways of governmental control are past finding out.

Another Word About the Railroads.

The Merchants' Association of New York is in favor of the plan proposed by the Railroad Executives for the future management and control of the railroads now under Federal control. It seemed to the Transportation Committee of The Association and to the Directors that this plan promised a greater amount of public service than any other, although all the various plans proposed have attractive features.

The association has also declared positively against dumping the railroads back upon their owners, without instructions from Congress, before the expiration of the period, which was set as the limit of Federal control.

Air Brake Department

The Frictional Interrelation Between the Component Parts of the Air Brake System —Questions and Answers

W. F. Dean, a leading air brake expert, in speaking before a meeting of the Air Brake Association recently said that the complexity of the air brake system is familiar to all who have to do with air brakes. The system is complex because of the number and interrelation of its parts. And, because of this, many people, in their close attention to one phase of the air brake problem, overlook the other phases and their relation to the one attracting the most interest at the moment. It is the old question of the tree and the forest, one is so occupied in studying the tree that the forest escapes attention. For instance, many relate wheel sliding directly to braking power, or, to use the more correct term, braking ratio, and forget that there are many more factors involved than merely this one of braking ratio. Again, air brake devices frequently are given close scrutiny as to air-handling performance, that is, performance which is necessarily limited to the delivery and release of air at the brake cylinder, without tracing the braking problem right on through from that point to the wheel and to the rail.

The many parts of the air brake system are interrelated in either one, or both, of two ways; viz., in series or in parallel, to use the familiar electrical terms. Parts arranged in series fall in, one behind the other, like the links of a chain. The failure of any one part puts all the other parts in the series out of commission, and obviously the whole series can be no more efficient than the least efficient part, just as the strength of a chain is limited to its weakest link. The brake installation of a single car, starting at the branch pipe tee and ending at the rail, is of this type. Any interference, such as a closed cut-out cock, a faulty triple piston ring, a badly leaking packing leather, or a broken pull rod, renders the whole series totally inoperative.

On the other hand, the brake equipments on each individual car are in parallel one with the other. The brake pipe is the supply circuit and the rail the return circuit, to use our electrical analogy, and each brake equipment extends from the one (the brake pipe) through the branch pipe, air handling devices, cylinder, foundation brake gear, and wheels to the other (the rails). The disablement of one equipment does not impair the others except for the transfer of the load or performance of this disabled equipment to the others. If the braking ratio, other things remaining equal, be taken as the measure of braking effectiveness for any car, then loading the car without increasing the braking force to keep the braking ratio constant, means that this parallel circuit is over-loaded and the excess braking effort must be transferred to the other circuits (equipments) in the train.

The foregoing method of viewing the problem is not offered for any cash value it may have. It merely serves as an illustration of the dependence in operation of each part of the air brake system upon the operation of each and all of the other parts. It may be surprising to state that the air brake system for a train not only includes the more obvious parts such as air compressor, main reservoir, brake valve, brake pipe, each triple valve, auxiliary, brake cylinder and foundation brake gear, but also the truck and car construction, the wheels and the rails, and even the road bed and the weather.

As the motion of a train is referred to the rails and to the earth as a base, all motion being relative in nature, so also must the braking problem start with the rail and fundamentally depend upon it. Obviously, could all the weight of a train be removed in some miraculous manner from the wheels at the time of a brake application, not only would all the wheels slide but the rails would offer no resistance to the sliding wheels, with the result that no retarding effort whatever would be exerted by the rails upon the moving train. Therefore, it is upon the friction which can be set up between the wheels and rails, and which is due to the weight imposed by the wheels upon the rails, that we must depend for retarding force with which to stop a train. This friction, or adhesion, is a maximum when the wheels are rolling and a minimum when they slide for the same reason that the fritcional resistance to be overcome in pushing a heavy table is greater in getting it started than in keeping it moving. Thus in applying brake shoes to a pair of wheels a balance of equal frictional forces is set up, the brake shoe friction tending to slide the wheels, and the wheel-rail friction keeping the wheels in rotation. However, if the brake shoe friction exceeds the maximum possible wheel-rail friction, or adhesion, that is, if the pull of the brake shoes tending to lock the wheels is a greater force than the pull of the rail, which tends to keen the wheels turning, the wheels, of course, will slide. Here, as in all other cases, there is a balance of forces, the decision going to the greater force.

Questions and Answers

Locomotive Air Brake Inspection.

(*Continued from page 52, Feb., 1919.*)

675. Q.—What is the object of cross slotting the boss of the air valve?

A.—To prevent the possibility of the valve wearing to such a perfect fit against the valve chamber cap that the air pressure would not permit it to seat promptly.

676. Q.—What should in all cases be applied to the threads of a valve chamber cap or an air valve seat or cage before it is screwed into place?

A.—A coating of a mixture of oil and graphite, and this should be valve oil.

677. Q.—What should in all cases be done before screwing a discharge valve cage into place?

A.—A standard tap for the purpose should be used to true up the threads.

678. Q.—Why so, if the threads are apparently in good condition?

A.—On account of uneven thickness of the metal surrounding the cage, the heating of the cylinder and the consequent uneven cooling results in warping this cavity, the threads of which should in all cases be trued up before applying a cage.

679. Q.—What causes the cages to become loose in the threads?

A.—The heating of the compressor tends to shrink the brass cage, and whenever found screwing in very loosely the cage should be renewed.

680. Q.—What is the effect of having a valve too loose in the cage?

A.—It will roll about, leak, and pound the valve seat out of shape.

681. Q.—Should all valves have the full lift specified when fitting them?

A.—It will be found to be of advantage to have the lift a trifle less than the figures specified so that when they have worn to a good bearing the lift will not exceed the figures given.

682. Q.—Assuming that the compressor is ready to be assembled, what is to be observed in connection with the gaskets?

A.—Unless the middle gaskets are absolutely known to be in good condition and have been re-grooved, new gaskets should be used, it is preferable to use new gaskets between the cylinders and center piece.

683. Q.—What else is to be done in an effort to obtain a tight joint?

A.—The bolting faces of the cylinders and center piece are to be thoroughly cleaned, and a mixture of valve oil and graphite must be used on tap bolts and in bolt holes.

684. Q.—What is the result of a failure to use a coating of some such substance on tap bolts in the cylinders or top heads?

A.—A great deal of unnecessary drilling out of broken and corroded bolts with the consequent damage to threads in holes.

685. Q.—What is the essential condition in maintaining a compressor in a high state of efficiency?

A.—An accurate fit of parts and clean air passages.

686. Q.—Can a fit of parts be obtained if the cylinders or bushings are worn?

A.—No.

687. Q.—What is considered to be the most convenient method of maintaining a fit of parts in the top head of the 8½ ins. compressor?

A.—Rebushing the heads, so that a standard size of pistons and rings may be used.

688. Q.—What is the standard size of main valve pistons in the 8½ ins. compressor?

A.—Small, 2 5/16 ins. exhaust, 2½ ins. and large piston 3⅜ ins.

689. Q.—What is the most economical method of maintaining a fit of parts in the top head of the 9½ ins. and 11 ins. pumps?

A.—The general practice is to rebore the main valve bushing and the left main valve cylinder head and to apply larger than standard sizes of pistons.

690. Q.—How often may the parts be rebored?

A.—4 times, or in steps of 1/32 ins. at a time until a piston 2¼ ins. x 3⅛ ins. has been used.

691. Q.—What is the standard size of main valve piston for the 9½ ins. pump?

A.—2⅛ ins. x 3 ins.

692. Q.—For the 11 ins. main valve pistons?

A.—Small end 2 11/16 ins., large 3 13/16 ins.

693. Q.—What is the maximum size furnished?

A.—2 13/16 ins. and 3 15/16 ins.

694. Q.—What is to be observed in connection with the reversing valve?

A.—That it has a perfect bearing on its seat and that it fits the bushing.

695. Q.—What is the most economical method of maintaining air and steam cylinders in a condition to insure a fit of parts?

A.—By reboring them when worn and applying pistons to fit.

696. Q.—Are air and steam cylinders ever rebored and bushed?

A.—It has been done in some shops, but the practice is not general.

697. Q.—How should a piston fit an air cylinder?

A.—It should be a close fit, the cylinder should be bored to the same size as the outside diameter of the piston.

698. Q.—What if the piston will not enter the cylinder?

A.—A trifle can be filed off the piston, and an effort should be made to have the piston pass through the cylinder with some friction.

699. Q.—How should packing rings be fitted to a cylinder?

A.—They should have a bearing all the way around in the cylinder and lap over a trifle at the ends.

700. Q.—How should they fit the groove of the piston?

A.—They should fit neatly without binding and make a tight joint at the ends as well as at the wall of the cylinder.

701. Q.—What will be the result of lapping the rings at the ends?

A. It will be necessary to drive the pistons through the cylinders when fitting up the pump.

702. Q.—Should the sides of a packing ring ever be filed to fit a groove?

A.—No, it invariably results in leakage past the rings.

703. Q.—How can this be avoided?

A.—By maintaining a standard size of ring and piston groove.

704. Q.—How are the main valve packing rings fitted?

A.—In the same general way as to fit at the ends and in the groove, they should lap so that they will go through the cylinders with some friction and after a bearing has been obtained by grinding the ends should be filed off just enough to allow them to pass through the cylinders freely.

705. Q.—How should they be fitted in the top head of the 8½ ins. compressor or in the steam head of the 5A and 6A compressors?

A.—In the same way as previously outlined, but when finished the rings should not be allowed to lap over enough to prevent the main valve or valve stems to be moved by hand.

706. Q.—What is the most important thing to be observed after cylinders or main valve cylinders and bushings are rebored?

A.—To be positive that they are correct in alignment, that is, that they have been bored straight.

707. Q.—How is this ascertained?

A.—By passing the pistons, attached to the rods, through the cylinders before the rings are applied.

708. Q.—How is it done after the main valve bushing has been rebored?

A.—By temporarily bolting the left main valve cylinder head in place and knowing that the main valve pistons pass through the rebored parts freely before any attempt is made to assemble the head or fit the rings.

709. Q.—What should be done in the event of a worn reversing valve bushing?

A.—The bushing should be removed by pressing it out of the head and a new one should be applied, on 9½ ins. pumps.

710. Q.—Are these bushings ever reamed and trued up?

A.—It is being practiced in some shops, but in all cases where it is done, a larger size reversing valve is applied.

711. Q.—What is usually done with a defective reversing valve seat in the 8½ ins. and 11 ins. compressors?

A.—The seats are faced off and new valves are applied.

712. Q.—What care must be taken in applying a new bushing?

A.—To see that the steam ports are in alignment and that the reversing valve chamber cap has a bearing on the top of the bushing as well as on the head.

713. Q.—What should be observed in connection with the steam piston and rod?

A.—That the piston rod is not worn materially at any point.

714. Q.—What may be done if it is worn?

A.—It may be trued up in a lathe, but it should never be allowed to become 1/16 in. below the standard thickness.

715. Q.—How should the stuffing box glands fit the rod?

A.—They should be a neat sliding fit on the rod.

716. Q.—What should be the maximum difference between the thickness of the steam piston packing ring and the width of the piston groove?

A.—The packing ring should not be more than .005 ins. loose in the groove.

(To be continued.)

Train Handling.

(Continued from page 53, Feb., 1919.)

705. Q.—What is the object of a leakage groove in the cylinder?

A.—To keep the brake from applying if but a very small quantity of air enters the brake cylinders.

706. Q.—Or in other words?

A.—To keep undesirable leakage from applying the brakes, as well as to keep slight movements of the triple valves from applying them.

707. Q.—What causes a leak at the exhaust port of a distributing valve when the brake is released?

A.—Application slide valve or emergency slide valve leakage.

708. Q.—When the brake is applied?

A.—Exhaust valve leakage.

709. Q.—What causes a blow at the emergency exhaust port of the automatic brake valve while the brake is released?

A.—It is usually leakage from the equalizing slide valve of the distributing valve.

710. Q.—How is the engine brake cut out?

A.—By closing the stop cock in the brake cylinder pipe.

711. Q.—What is the brake valve double heading cock used for?

A.—To be closed when another engine is hauling the train.

712. Q.—Should the air compressor be running if another engine is operating the brakes?

A.—Yes.

713. Q.—Why?

A.—To keep a supply of air in the main reservoir for the operating of the brakes.

714. Q.—What if the compressor on the second engine is broken down or the engine "dead"?

A.—The stop cock in the dead engine fixture pipe is opened to charge the main reservoir from the brake pipe.

715. Q.—What would be done if there is no dead engine fixture?

A.—The double heading cock would be left open, and the adjusting screw of the feed valve slacked off to maintain about 10 lbs. pressure, and the brake pipe exhaust of the automatic brake valve would be plugged.

716. Q.—What would be the positions of the brake valve handles?

A.—Running position for both handles?

717. Q.—The result if one of the handles was moved away from running position?

A.—The brake could not be released from the lead engine.

718. Q.—How are brake valves generally kept in the proper position when engines are being hauled over the road "dead"?

A.—With special clamps to hold the valve handles in running position.

719. Q.—What causes brake cylinder pressure to increase after a light application with the automatic brake valve?

A.—A leak into the application cylinder of the distributing valve, or leakage from the brake pipe to the atmosphere.

720. Q.—What will cause brake cylinder pressure to decrease after the brake valve is lapped after a light reduction?

A.—Leakage from the application cylinder or its connections to the atmosphere.

721. Q.—What two principal things can an automatic brake valve do?

A.—Admit compressed air from the main reservoir to the brake pipe, and discharge air from the brake pipe to the atmosphere.

722. Q.—Anything else?

A.—Act as a retaining valve for the distributing valve.

723. Q.—Why is the valve composed of so many different parts, if this is all that it can do?

A. Because the flow to and from the brake pipe is controlled in two different ways.

724. Q. What are they?

A.—Direct and indirect.

725. Q. Does the brake valve control any other flow of air?

A.—Yes, but it is merely a flow to the excess pressure top of the pump governor and to the application cylinder of the distributing valve while the valve handle is in emergency position, and no additional apparatus is required.

726. Q.—How many positions has the straight air brake valve of the LT equipment?

A.—Five principal positions.

727. Q.—Has this valve an automatic release position?

A.—Yes, the engine and tender brake can be released with the straight air valve in automatic release position after an application with the automatic valve.

728. Q.—What parts of the control valve move when the automatic brake valve is moved to service position?

A.—Both the triple valve and application portions.

729. Q.—What parts when the straight air brake is applied?

A.—Neither one of the control valve portions.

730. Q.—Is there any flow of air through a brake valve when the handle is on lap position?

A.—None other than a flow from the main reservoir into the feed valve pipe and spring chamber of the excess pressure governor top.

731. Q.—What are the names of the three different exhaust ports of the automatic brake valve?

A.—The preliminary, service and emergency exhaust ports.

732. Q.—Where is the exhaust port of the independent brake valve located?

A.—In the central part of the pipe bracket under the valve body.

733. Q.—Where is the preliminary exhaust port bushing of the automatic valve located?

A.—In the rotary valve seat.

734. Q.—Through what port does it discharge air?

A.—Through the emergency exhaust port to the atmosphere.

735. Q.—How long will it take to make a 7 lb. equalizing reservoir reduction from 110 lbs. with the brake valve in service position?

A.—2 seconds.

736. Q.—And from a 70 lb. pressure?

A.—3 seconds or a trifle over.

737. Q.—How is this figured?

A.—From one third of the time required to make a 20 lb. equalizing reservoir reduction under the two different pressures.

738. Q.—What is generally wrong when the flow of air through a preliminary exhaust port becomes suddenly restricted?

A.—Generally a piece of pipe scale has lodged in the preliminary exhaust port bushing.

739. Q.—How may a leaky equalizing packing ring in a brake valve sometimes manifest itself?

A.—After making say a 10 lb. equalizing reservoir reduction with a long train of cars, the gage may show but about 8 lbs. reduction after the brake valve service exhaust port has closed.

740. Q.—How is a feed valve or pump governor adjusting nut turned to increase the pressure carried?

A.—By turning the adjusting nut to the right.

741. Q.—Do pressures reduce promptly if the adjusting nut is turned to the left?

A.—No, the pressures must be reduced below the tension remaining on the adjusting spring, or time must be allowed for it to reduce through leakage.

742. Q.—Should there ever be any occasion to change the adjustment after an engine leaves the shop with correct pressures?

A.—Not unless the engine goes into a different class of service than was intended when the engine was despatched.

743. Q.—Can anything be done with the adjusting screw of the feed valve if it fails and permits main reservoir pressure to enter the brake pipe?

A.—Generally there can not, the only thing accomplished is a change of tension on the adjusting or regulating spring.

744. Q.—What is the result if the feed valve disorder is but temporary?

A.—Incorrect adjustment, involving further adjustment and frequently further trouble when the feed valve again starts to operate.

(To be continued.)

Car Brake Inspection.

(Continued from page 54, Feb., 1919.)

632. Q.—What prevents the uniform operation of brake in freight trains?

A.—The time required to create the necessary differential in pressure on the rear cars of a long train.

633. Q.—Or in other words?

A.—The volume of brake pressure to be handled and the pipe friction encountered.

634. Q.—Has anything ever been done in an effort to reduce the time required to operate brakes on long trains from the locomotive?

A.—Type K triple valves have been designed for the purpose of making brake operation on long trains more uniform.

635. Q.—What kind of type K valves are now in general use?

A.—The K-1 and K-2 valves.

636. Q.—What sizes of brake cylinders are they used with?

A.—The K-1 for 8 in. cylinders and the K-2 for 10 in.

637. Q.—Have these valves all of the features of the H valves?

A.—Yes, and certain other improvements in addition.

638. Q.—What features are added?

A.—Quick service, uniform recharge of the auxiliary reservoirs and a restricted release.

639. Q.—What is gained by the quick service?

A.—Each triple valve as it moves to service application position makes a local brake pipe reduction by admitting air from the brake pipe to the brake cylinder and this positively continues the reduction throughout the train.

640. Q.—With H valves on a 100 car train how many of the brakes can be applied with a 5 lb. brake pipe reduction?

A.—About 35 or 40 on the head end.

641. Q.—With a 10 lb. brake pipe reduction?

A.—Possibly 75 brakes.

642. Q.—Will a 15 lb. brake pipe reduction apply all of the operative brakes in a 100 car train?

A.—Not as a general proposition, a 15 lb. reduction will be required, but some of the brakes near the middle of the train will usually fail to apply?

643. Q.—Why so?

A.—Because all of the compressed air leaving the brake pipe, except that lost through leakage must pass through the brake pipe exhaust part of the brake valve and as the brake pipe pressure is being reduced at the head end of the train, the flow forward from the rear end tends to maintain the pressure in the middle of the train and the brake pipe reduction is so slow that the auxiliary reservoir pressure has a chance to reduce by flowing into the brake pipe through the triple valve feed grooves without moving the triple valve pistons.

644. Q.—In a practical way, what does the pipe friction or the frictional resistance to the flow of air amount to in brake operation?

A.—It delays and tends to destroy the application of brakes and tends to cause failures of the brakes to release.

645. Q.—To what extent does it retard the flow of air from the brake pipe?

A.—To such an extent that if the triple valves are put out so that they will not assist in the brake pipe reduction, the brake pipe pressure can be exhausted from a long brake pipe with the brake valve in service position as quickly as it can with the brake valve in emergency position.

646. Q.—Or in other words?

A.—There is enough resistance to the flow of air so that the volume of the brake pipe can be exhausted as quickly with a 9-32 in. circular opening as it can with a 5/8 in. opening.

647. Q.—Why so?

A.—Because it requires just so much time to expand this compressed air and withdraw it through the various cracks and turns in the piping.

648. Q.—What effect on the release of brakes or the admission to the brake pipe?

A.—That if an air gage is attached to the brake pipe 30 cars back in the train, the increase in brake pipe pressure will be so slow that from an observation of the gage hand it will be impossible to determine whether the brake valve is in release or in running position.

649. Q.—What is then the one insurmountable obstacle in the prevention of uniform brake operation on freight trains?

A.—The large volume of compressed air in the brake pipe.

650. Q.—What is the difference in the amount of air discharged from the brake valve during an application where K valves are used?

A.—Only about one-half of the volume is discharged as when H valves are used on the same length of train.

651. Q.—What becomes of the other half of the volume that would otherwise be discharged with H valves?

A.—It is admitted to the brake cylinders.

652. Q.—Does this make any material difference in the final brake cylinder pressure obtained?

A.—No, only two or three pounds more will be obtained.

653. Q.—Will this reduction added to that of the brake valve not tend to produce undesired quick action?

A.—No, when the rate of brake pipe discharge is almost equal to the capacity of the triple valve service port to expand auxiliary reservoir pressure, the triple valve will be moved to full service position and the quick service part will not be operative.

654. Q.—How does the valve then operate on a short train?

A.—The valve does not assume quick service position but momentarily, or when the quick service feature is not required to hasten the brake pipe reduction. It is automatically cut out.

655. Q.—What is meant by retarded release?

A.—When the brake pipe pressure is three or more pounds in excess of or higher than the pressure in the auxiliary reservoir, the retarding spring is compressed and the triple valve is moved to restricted release position, in which the exhaust of brake cylinder pressure is restricted.

656. Q.—To what extent?

A.—So that the brakes on the rear of a moderate length of train will release uniformly with the brakes on the head end.

657. Q.—How far back in the train can this difference in pressure be obtained to force the triple valves to this position?

A.—As far back as 25 or 30 cars if the brake valve is allowed to remain in release position for about 15 seconds.

658. Q.—What does this restricted release do?

A.—Prevents the slack from running out when a release of brakes is made or assists the engine brake to hold in the slack during a release.

659. Q.—How is uniform recharge secured?

A.—When the triple valve is in retarded release position one of the feed grooves is also closed and the auxiliary reservoirs can charge but about one-half as fast as when the valve is in normal release position with both grooves open.

660. Q.—What returns the triple valves at the head end to normal release position?

A.—When the brake pipe and auxiliary reservoir pressure are within 3 lbs. of each other, the springs of the retarding device return the triple valve piston to normal release position.

661. Q.—How much of a brake pipe reduction will be required to apply the brakes on a 100 car train with these types of triple valves?

A.—A five pound reduction will be propagated through the entire train and will apply all of the operative brakes.

662. Q.—When a car weighing say 40,000 lbs. is equipped with a brake what will be the percentage of braking ratio?

A.—Usually 60 per cent. of the light weight of the car which is then based upon a 50 lb. pressure in the brake cylinder.

663. Q.—Why is the ratio so much lower than for passenger cars?

A.—The speed of freight cars is much slower and the slower the speed, everything else being equal, the more effective the brake shoe is in retarding the speed of the wheel.

664. Q.—Why is this?

A.—Because a brake shoe when closely examined will be found to have abrasions or elevations and depressions all over the bearing surface and at slow speeds these uneven surfaces tend to interlock while at high speeds the rapid turning of the wheels tend to break them off and the shoe has much less frictional effect.

665. Q.—If the car is braked as outlined and the car is then loaded, say with about 100,000 lbs., what will the percentage of braking ratio be, or that which is generally termed percentage of braking power?

A.—About 17 per cent. of the total weight of load and car.

(To be continued.)

Electrical Department

The Selection of the Correct Electric Locomotive for Satisfactory Operation with Particular Reference to Freight Service

Many times in the study of electric railway problems quick and approximate results are only required. Where a complete study is to be made for electrification it is necessary to consider grades and curves in detail and a very careful check made of the service conditions. Speedtime curves are then drawn and the capacity of the electric locomotive can be determined accurately. But there are problems which may come up where only approximate results are wanted and where it is not necessary to take the time to calculate the typical run and speed-time curve.

There are several factors which determine the electric locomotive equipment, some of which do not appear at first thought as important. It is an easy matter to choose a locomotive that will be more than large enough to perform a given service, but to select one that is just the right size—one that is of minimum first cost and hence minimum weight—requires a certain amount of study.

To pull a trailing load of a certain number of tons, the motors of an electric locomotive must be capable of exerting a certain number of pounds tractive effort at the rim of the driving wheels. We know that a tractive effort of from 15 to 25 lbs. per ton of trailing load is required to bring up to speed a train standing on a straight level track and that about seven pounds per ton trailing load is required to maintain constant speed.

The characteristics of the electric locomotive are somewhat different from those of the steam locomotive. The steam locomotive consists of two distinct parts, the boiler and the engine, each of which is designed for the service in which the locomotive is to be placed. The boiler has its limits in size and must therefore be worked at its maximum capacity. It is distinct from the engine. The power the engine is capable of delivering at the drivers depends on the mechanical dimensions and any variation in the tractive effort is due to change in boiler pressure, since the engine is fixed. The maximum tractive effort usually corresponds to about 22 per cent. adhesion between the drivers and the rail, so that it is not possible to start a heavier load even if the coefficient of adhesion were raised by means of sand.

The electric locomotive is not a self-contained unit. It has, in comparison with its own power, an unlimited supply of power to draw on. The number of motors and the characteristic curves of the motors, determines the tractive effort the electric locomotive is capable of developing. The torque of the motor is, however, entirely different from the power obtained in the steam cylinder. Its value depends on the amount of the electric current which passes through the motors. This current is under the control of the engineer, so that as large a torque as desired can be obtained, within safety limits. It is, therefore, possible to take advantage of extra adhesion, obtained by the application of sand, and there is little chance of becoming stalled.

In starting up an electric locomotive, a resistance or equivalent apparatus is provided to limit the current to a safe value. A certain tractive effort is thus maintained as the locomotive speeds up, obtained by the reduction of resistance step by step. The constant tractive effort can be maintained until all the resistance is cut out, after which it will decrease as the speed increases.

While the electric locomotive has the great advantage of a large maximum tractive effort, it is impossible to maintain it continuously on account of damage which would result to the motors. The capacity of the electric locomotive depends on the temperature of the motors. The greater the current the shorter the time it can be passed through the motor without overheating, so that large tractive efforts can only be maintained for short periods. Each locomotive has a time-temperature current curve which will tell just what temperatures may be expected and how long a certain current can be used without overheating. This question of heating and tractive effort was covered in detail in the issue of September, 1918, page 296. A small motor can exert a comparatively enormous tractive effort for a few minutes, but the heat developed would burn up the windings if the tractive effort was maintained. An electric locomotive may be large enough to haul a certain train over level track and not exceed a safe temperature, but if operated on long grades with the same train it might burn up.

Sufficient adhesion must be available so that the motors can exert their normal tractive effort, so that the locomotive must be of enough weight. If it is too light, the wheels will slip when an attempt is made to start or to pull a load up a grade, which otherwise would be within the capacity of the motor equipment.

The maximum tractive effort is limited by the locomotive weight and is not wholly determined by the motors. The weight of the locomotive should not be too great for the motors, as the wheels would not slip until after the motor was overloaded. The wheels should slip if an effort is made to obtain an abnormal maximum tractive effort, and the locomotive weight should be proportioned in relation to the motors.

As mentioned above, oftentimes approximate results are required and we are showing how these results can be obtained directly from curves. Examples are given to show how these curves are used. The curves give approximately the weights and capacities for freight service. In using the curves, the gear ratio must be so chosen that the desired speed will result. In the case of locomotives, the lowest speed gearing that an equipment will take, is found most suitable.

Example No. 1—Practically Level Road—Horsepower of Motors and Speed in Miles Per Hour Known—Find Weight of Locomotive and Trailing Load.

We will assume an equipment consisting of four 175 horsepower (one hour rating) motors and that the speed of the equipment at its rated horsepower and voltage is 12 miles an hour. (a) What is the maximum weight of locomotive in weight on drivers, suitable for this equipment? The rating of the equipment is $4 \times 175 = 400$ H. P.

Fig. 1 shows the relation between the maximum weight of the locomotive for any capacity at any rated speed and for any rated tractive effort. The rated horsepower divided by the rated speed (12 m. p. h.) is $\frac{700}{12} = 58.3$. The weight corresponding to 58.3 is 75 tons. This weight will permit of a starting tractive effort considerably in excess of the one hour rating.

(b) What load can this 75-ton locomotive haul? To answer this definitely requires an exact knowledge of the profile of the road. We have assumed that the road is practically level, but there may be short

grades of 1.0 per cent, so that by reference to Fig. 2 the load can be determined. This curve, Fig. 2, is drawn up showing the relation between weight of maximum trailing load ÷ weight of the locomotive (or in other words the number of times its own weight) and the percent grade. Four curves are shown as labeled. By short grade we mean one of 1,000 ft. or less. If the grades were much over 1,000 ft. then the time of hauling the load over the grade would be sufficiently long, so that the effect of momentum would be lost, and the load on the motors as taken from the "short grade" curve would be excessive. It would be necessary to refer to another curve and so the "Long Grade" curve has been drawn in for these conditions.

Referring to Fig. 2 with short grades of 1.0 per cent. it will be noted that the locomotive can handle a load of 17 times its own weight, so that in this example the trailing load would be 17 × 75 = 1,275 tons. But if the grades were of more than 1,000 feet then it will be noted that only loads of 9.2 times the locomotive weight can be handled, or 690 tons.

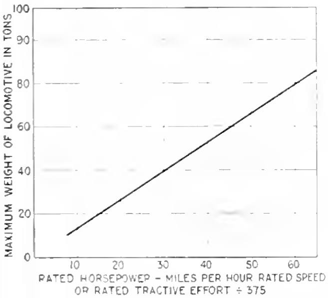


FIG. 1—CURVE SHOWING MAXIMUM WEIGHT OF LOCOMOTIVE FOR ANY CAPACITY AT ANY SPEED OR FOR ANY RATED TRACTIVE EFFORT.

The above determination of tonnage should be checked against the load which the locomotive can handle continuously under average conditions. The continuous rating is different, depending on whether the motors are ventilated or have natural ventilation. It is now almost universal practice to equip electric locomotives with blowers and ducts so that air can be blown through the motors, thus carrying away the heat and increasing the capacity. A forced ventilated motor is much smaller and lighter for a given horsepower than one without a blower.

The assumption was made that the road was practically level. Referring to Fig. 2 at 0 per cent. (level) the locomotive at continuous rating with forced ventilation will haul 20 times its own weight, and at continuous rating natural ventilation will haul 11 times its own weight. This means then, that if forced ventilation is considered the locomotive capacity is limited by the 1.0 per cent. short or long grade, but if natural ventilation is considered

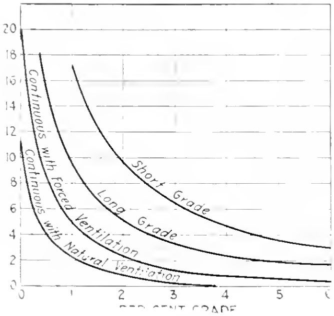


FIG. 2—CURVE SHOWING NUMBER OF TIMES ITS OWN WEIGHT A LOAD MAY BE HAULED BY LOCOMOTIVE WITH VARIOUS GRADE CONDITIONS.

then on the short grade the capacity is not limited by the grade, but by the continuous rating, and on the long grade, by the grade.

Example II — Speed and Locomotive Weight Known—Determine Minimum Equipment.

Suppose a locomotive with a rated speed of 20 miles per hour is desired and that the construction of the roadbed limits the weight of 80 tons. What is the minimum equipment for such a locomotive? Referring to Fig. 3 is will be noted that at 20 miles per hour the minimum rated horsepower per ton is 15. Hence the rating of this 80 ton locomotive should not be less than 1,200 horsepower. The performance of the equipment can be determined as in Example 1. If it is not sufficiently large more powerful motors may be applied.

The electric current demand for a freight

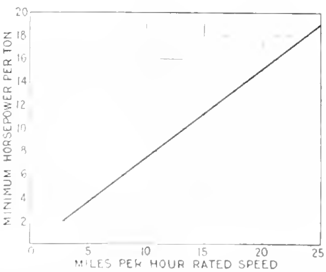


FIG. 3—CURVE SHOWING MINIMUM RATED CAPACITY OF ANY LOCOMOTIVE AT ANY RATED SPEED.

train depends primarily upon the speed train weight and grades, and secondarily upon the alignment, average weight of car, frequency and duration of stops. The power is furnished from substations and it is very essential not to get a locomotive capable of handling large tonnage, but which cannot be used to its full capacity on account of taking too much current. The curves shown, Fig. 4, will be found useful in selecting the maximum weight of train to be handled within any fixed current limit.

Suppose the maximum grade on a road is 2 per cent. for 3 miles and it is so located that all the power for climbing it must be taken from a 1,200 ampere substation. A speed of 10 miles an hour is desired on this grade. For such a grade the substation can work at 50 per cent. overload so that it can deliver 1,800 amperes. Fig. 4 shows that at 10 m. p. h. on a 2 per cent. grade 2.25 amperes per ton are required. Hence the maximum weight of train at this speed is 1,800 ÷ 2.25 = 800 tons, including locomotive weight. If 20 miles per hour were desired the train weight would be limited to 400

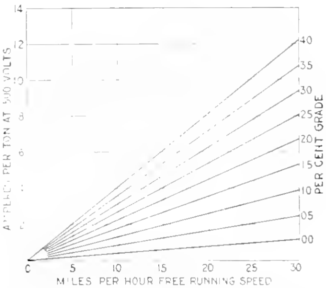


FIG. 4—CURVE SHOWING CURRENT OF ANY FREE RUNNING SPEED ON VARIOUS GRADES.

tons—if 6 miles an hour the train weight would be 1,200 tons. The effect of speed on power demand is apparent and for any specific proposition, the choice lies between speed and tonnage in a single train.

Waterproofing Blue Print.

Immerse in melted paraffin until saturated a number of pieces of an absorbent cloth one foot or more square. When withdrawn and cooled they are ready for use at any time. To apply to a blue print, spread one of the saturated cloths on a smooth surface, place the dry print on it with a second wax cloth on top, and iron with a moderately hot flatiron. The paper immediately absorbs paraffin until saturated, and becomes translucent and completely waterproof.

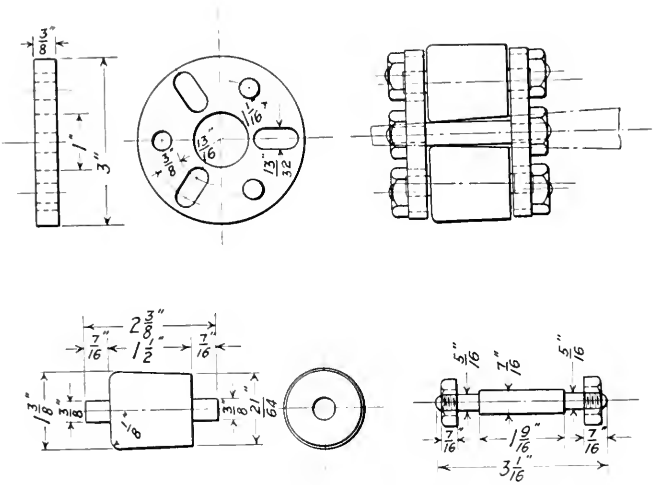
Cooling Drills

Where oil will not act as a cooling lubricant on a drill working in hard metals, turpentine used instead will induce the drill to take hold of the metal, and also retain the temper of the drill.

Expanding Tool for Locomotive Arch Pipes.

By A. C. Clark, Pittsburgh, Pa.

The accompanying drawing shows the details of a handy tool for expanding the ends of locomotive arch tubes in the boiler sheets. For a considerable period during the war, we had a lot of borrowed locomotives from the Santa Fe, and this tool was designed for use on the arch tubes of these engines. However serviceable in this particular case, the tool can readily be made to suit any size or condition that may be necessary. It will be observed that the parts are simple in construction consisting of two circular steel plates having three holes, 3/8 in. in diameter for connecting bolts; and three oblong holes for adjustment. The bolt used is illustrated, as also is the roller. The rollers have a taper of 3/8 in. per foot, and it therefore is necessary to have the expander pin tapered 3/4 in. per foot, so that the rollers will not have a tapered effect, but the outer surfaces will work in a perfectly straight line. The working parts are of tool steel finished and hardened, including the rollers and tapered pin. The bolt holes, as shown, should be equal spaced.



DETAILS OF EXPANDING TOOLS FOR LOCOMOTIVE ARCH PIPES.

Locomotive Fire Box Construction.

By William R. T. Kolp, Philadelphia.

I have read with a great deal of interest, in your January and February issues, regarding locomotive fire box construction with Nicholson's Thermic Syphons welded therein. The tests show what might be expected from the increased fire box heating surface as arranged. It goes to show how valuable increased heating surface in a fire box is. The question of gaining 53 square feet of surface is an item, especially where conduction is most efficient.

From the construction, as shown, it clearly goes without comment that the fire box has been made more rigid than it was in the regular type of boiler, and also the stays have not been diminished but increased by some 175. From a practical standpoint, there is not too much room for making repairs in the present type of fire box, and the trouble with the present type has been its rigidity. In order to overcome this different kinds of stays, called flexible, have been used to help relieve rigidity. Under such conditions, is it desirable to increase the rigidity and the number of stays with Mr. Nicholson's plan?

From my observation, and from the talk with constructing engineers, the question of rigidity in locomtive fire boxes should be gotten rid of, and the fire box made flexible. I read a description in your paper, some time ago, of the Wood flexible fire box and tube plates, written by your late and very able editor. The description given by him was so forcible in its argument it is very hard to understand why this boiler has not been universally adopted, from the fact that 729 stays are dispensed with in its construction, and by being made flexible it is also eight times stronger. From the copy of the tests during the four years workings, which I have before me, I find a saving of nearly seven per cent in fuel, and no stays were broken between the corrugations. I believe these boilers, which were made for the test, were made with improvised tools, to demonstrate the principles involved, and not as a finished product. It is a question whether the present locomotive fire box can be constructed and made, with all the drawbacks of rigidity to contend with, as cheaply as those which might be substituted in flexible form with all the advantages referred to.

Baldwin's Report for 1918.

From the annual report just published we learn that the Baldwin Locomotive Works has had the biggest year in its history. The total production for the year amounted to $123,179,252, much of which represented war work. According to the report, Baldwin's built more than 3,500 locomotives last year. In addition there were constructed for the Government 11 railway mounts for 14-inch guns and 16 caterpillar mounts for 7-inch guns, and production along this line had just reached its peak when the armistice was signed.

Among the Baldwin subsidiaries the Eddystone Munitions Company was probably the most widely known for its war work, but the Standard Steel Works at Burnham, Pa., was employed to maximum capacity during the year and turned out work worth nearly $25,000,000.

The munitions plant completed contracts aggregating $14,636,479, with nearly $6,000,000 additional in contracts, held up by the termination of the war and now awaiting adjustment. As the war has ceased and there is no further need for its product the affairs of the Eddystone plant are undergoing liquidation. The Baldwin plant has had $68,400,000 in Government contracts cancelled.

Government control of the railroads has not been altogether beneficial to Baldwin's, the report indicates, the value of the concern's patterns and drawings having depreciated about $2,000,000, due to standardization of locomotives by the Railroad Administration.

Blackening Steel.

Obtain a piece of an animal's horn. Heat the steel or iron until it is hot enough to burn the horn. The metal need not be heated to redness. Rub the horn well over the metal, and while still hot rub any charred pieces of horn with a piece of oily waste, and a burnished black surface will result.

The Dearborn Chemical Company has opened an office in Kansas City, Mo., on Walnut street, between 9th and 10th streets. G. M. Massen and W. H. Fairlamb, who represent the company adjacent to Kansas City, will have their headquarters at that office.

The American Expeditionary Force's Locomotive Repair Shops in France

The *Stars and Stripes*, an American military paper published in France, states one of the many satisfactory feats of the members of the American Expeditionary Force remain to be described as factors in winning the war was the speedy building and successful operation of the United States Government locomotive repair shops, near Nevers, Nievre, France, which incidentally is the only shop of its kind in that country, operated wholly by Americans.

The history of the building of this shop and the installation of the machinery—as modern as any locomotive shop in the United States—is but another tribute to the abilities of those soldiers who are doing the building—the Engineers.

Last July when a battalion of Engineers arrived to reinforce the companies that had been doing business there for a year, the present repair shops were only partially completed, with about one-third of the machinery in place. At that date even the locomotive pits were unfinished.

The buildings were completed in a few weeks. The installation of the machinery soon was accomplished. Cranes, some of them capable of lifting an engine from the trucks, turning it around and placing it the other way, lathes and innumerable other machines were set up.

A permanent power plant built on the same design and of the same capacity as those in use at the great railroad shops in the United States was constructed to replace the temporary one.

Then started a crusade against broken down, crippled, smashed and otherwise disabled locomotives. In the first month eleven locomotives were repaired. In the adjoining yard forty-five engines were pushed out to begin once more their journey through France.

The system of mapping out the work at the plant is interesting. When an engine that has been tugging at the front of long trains and mounting steep grades fags out, it is ticketed for leave at Nevers.

While waiting for entrance to the main hospital where 1,300 skilled locomotive surgeons are waiting to begin hammering and cutting, grinding and mending, the locomotive gets the once over by a corporal, who can tell whether the engine is malingering.

A diagnosis in the form of a preliminary report showing the nature of the repairs needed is sent to the office of the general foreman, who before the war used to attend to such ailments in one of the shops of the largest railroad system in the United States.

Here the work is mapped out. Perhaps a cylinder is cracked, perhaps a firebox is broken and perhaps there has been a collision. From the office of the foreman go sheets to each sub-division, consisting of the erecting, machine, boiler, wheel, forge, pipe and jacket, and tender shops. On these sheets is set forth the number of days it is expected each department will require to finish its task on the specified engine. If there is a slip up or back sliding or any other cause for delay, the general foreman hears about it the next morning and wants to know the reason why.

Rather than tell him why, the departments invariably keep up to scratch or ahead of the mark set for their work.

Not only are the American engines doctored at Nevers, but the giant French and Belgian locomotives find their way to the shops to worry the soldiers who boast of the simple construction of the locomotives operating in the A. E. F.

The average time that an American engine remains in the shops before the repairs are completed is ten days; for the French thirty-five days, due to the complexity of parts and the inability to get them in many instances. The Belgian engines usually remain twenty days.

While the locomotive repair work is the principal feature of the work at Nevers, equally gratifying results have been obtained in the car repair department. Cars smashed through collisions or with flattened wheels, or minus a wheel or two, are repaired. Hospital trains that have been constantly on the run are being thoroughly overhauled at present. Four hundred men, all of them experienced in the work, are engaged daily in righting and putting the cars into operation.

Railroad Electrification.

Before the Engineering Institute of Canada H. H. Vaughan, formerly superintendent of motive, Canadian Pacific Railroad, discussed the problem of railroad electrification from the viewpoint of the railroad man accustomed to handling steam locomotives throughout his lifetime. Mr. Vaughan explained that he had been out of railway work for several years past and that he was somewhat "rusty" on the progress made in railway electrification, but that from 1900 up to a few years ago he had been actively interested in discussing railway electrification, and that he had always hoped to see some portion of the C. P. R. electrified.

Electrification must have done a great deal, said Mr. Vaughan, to make railway men's lives more comfortable, because of the greater certainty of operation and the much less engine trouble. The bane of the motive power superintendent's life is the daily list of steam locomotives out of commission.

He defended the efficiency of the steam locomotive, however, and stated that he does not believe that the consumption of fuel in steam locomotives is so wasteful as had been stated. The examples shown, he claimed, were taken from lines where the conditions of operation did not make for efficiency with steam locomotives. Where the grades are good, such as from Ottawa to Winnipeg and Ottawa to Montreal, he believed that a low coal consumption would be shown per ton-mile. There is a saving in electrification, he said, but not so great as is generally supposed.

The repairs to electrical equipment must cost money, and he did not think that the comparison of maintenance costs was made upon a fair basis. The cost for electric locomotives, he maintained, had been taken for locomotives that had been in service only four or five years, whereas they had been compared with costs of operation of steam locomotives some of which had been in service for many years.

If a railroad were equipped with all new steam locomotives, he thought that the maintenance charges would be as low as electric railway maintenance charges. The steam locomotive requires little attention the first few years of operation, and after that the cost of maintenance increases steadily for ten or twelve years, when it must be rebuilt. Mr. Vaughan claimed that it had not yet been determined just how long an electric locomotive would run before being rebuilt, but he felt certain that it would play out some time or other and would have to be renewed just the same as any other engine. It is not the boiler and engine that costs all the money for repairs, he said, but the running gear and general breakages—happening alike to electric locomotives.

When he was on the C.P.R. he had investigated electrification frequently, he declared, and he was always interested in it and never opposed to it. He recognized its advantages in the way of smoke elimination and avoidance of delays. He had proposed electrification for the Quebec section of the C.P.R., intending to obtain 25-cycle power from Shawinigan; but when they estimated the cost, they found that they could strengthen their old bridges and buy more modern steam equipment at less expense, and they did that instead of electrifying.

Lubricant for Oil Stones.

A good lubricant for oil stones is made by taking one part of sperm oil and one part of kerosene mixed, or if desired two parts of kerosene may be mixed.

British Railroad Development.

The general manager of the Lancashire & Yorkshire Railway Co. in a recent address indicated the direction in which alterations may be introduced in the rolling stock and equipment of his own and other lines. He emphasized the importance of increasing the carrying or tonnage capacity of the ordinary freight cars, so as to reduce the number of trains as far as possible. He referred to the fact that an effort has been made from time to time to introduce a car similar to the box car of the American type, capable of carrying 30 to 40 tons, instead of the 10-ton car now generally employed on British lines; but the change has been opposed by the traders, who object to keeping fairly large stocks and insist on the rapid delivery of small consignments. This objection should be overcome by offering special inducements, such as lower rates for heavy traffic carried by the slower trains The war has brought about a necessity for the utmost economy in operation, which will continue for years to come, and this transition from a 10-ton car to a heavier type has thus assumed a new importance, and is especially to be considered at a time like the present, when large quantities of new rolling stock are required. At all events the opinion is growing that the bulk of the coal traffic could readily be transported in the 40-ton cars.

Master Boiler Makers' Convention.

The Master Boiler Makers' Association announces that the regular annual convention will be held this year on May 26, 27, 28 and 29, at Chicago. The Hotel Sherman has been selected as headquarters. As this will be the first convention since the 1916 meeting, and as this organization has been recognized and encouraged by the railroads on account of its educational value, master boilermakers, boiler shop foremen, general boiler inspectors and all other employed in a similar capacity are urged to make every effort to attend this year—as far as they can be spared without detriment to the service. Each road should follow its usual practice with respect to allowance of time and expenses and furnishing transportation for men who may properly be permitted to attend this convention.

Provides for Enlisted Employees

Arrangements have been made whereby all employees of the Pennsylvania Railroad who were furloughed for military service will be given their former positions, or positions equally good, when they return to duty after having been honorably discharged by the government Announcement to this effect was made by the company and is being rapidly put into operation.

The Future Status of the Railroads

By the Assistant Director of Operation

C. A. Morse, assistant director of operation in charge of engineering and maintenance, United States Railroad Administration, in a finely prepared paper read recently before the members of the New York Railroad Club, stated that we are now in the position of having been rudely awakened by the war conditions, to realize that the transportation facilities of the country are what they have so often been called—but so little realized—the arteries through which must flow the life blood of the nation, and to appreciate that they must not be permitted to be clogged longer by unwise laws, improper regulation, antiquated agreements or customs, that permit of discrimination in favor of individuals or corporations. The railroads are today owned by individuals, but operated for the benefit, not alone of the owners, but of the public at large, and in this operation three things are absolutely necessary in order to make a properly balanced equation—justice to the investors, justice to the public, and justice to the employe. Justice does not mean *favor*, it ceases to be justice when it favors any one of the three interested parties. The past history of the railroads is well known, but it has been greatly camouflaged by the taking of the railroad question into politics. We have heard much of the political activity of the railroads—of the railroad stock gambling by Wall Street, of the poor management and lack of efficiency of the railroads—but we have heard very little of the heartaches of the stockholders of these same railroads, the loss of the widow's small inheritance, the retired business man's nest egg on which he depends for support in his old age, the investment by Savings Banks, Life Insurance Companies and Trust Companies in railroad securities of trust funds and life savings, the owners of which have had to suffer losses due to the failure of the railroads to earn enough to keep them out of receivership.

The public has seemed to feel that the railroads had money to burn, that all they had to do was to go down into their pockets and dig up the money with which to make any improvements that Federal, State or Municipal authorities might order. Fancy and elegant station buildings, and Union Depots, which do not earn a dollar, but increase cost of operation and maintenance; track elevation, separation of grades with county roads; improvements of grade crossings, including bells, and sometimes crossing watchmen.

All of these necessitate the borrowing of money, with its necessary interest charges to be paid out of operating income, with a constant effort to reduce rates—or no appreciable increase granted in rates, notwithstanding a constant increase in cost of labor and material—the result is plain—there comes a time when, regardless of curtailment of upkeep, which should not have taken place, the earnings fail to pay expenses and interest on the bonds—and they fail.

When a railroad fails it is not permitted to shut up shop. Instead of this, receivers are appointed. They go on operating at a loss—and the property is finally sold. A heavy expense bill is paid out of the proceeds to cover the cost of the receivership. The stockholders get little or nothing. The bondholders have to take a scaling down of their securities. A new company is formed that buys in the property for less than it would cost to reproduce it. They continue to operate it and after a cycle of years they get up against the same thing that the original company did—fail, are sold out, securities are shrunk, new company formed and so on as long as they are obliged to operate under laws such as we have today, and they are regulated as they have been in the past.

Is this justice to the investor? Of course it is not! So our equation has failed, and we must correct if possible the cause of failure.

There has been a law in force for many years, that was passed originally to prevent monopoly. This law makes pooling between the railroads unlawful, and forces competition, which is uneconomical, and extremely expensive. The first thing that the Government did when it took over the railroads was to disregard this law, and to pool both freight and passenger business with marked economy.

Before the railroads are returned to private ownership, this law should be revised so as to permit the same operation under private control as was found necessary and economical under governmental operation. Proper provision should be made in the new law to give the public protection from anything that would be against the public interests.

Regardless of which of the various methods may be finally adopted for handling the transportation of the country, it will be necessary to enlarge the duties of the Interstate Commerce Commission in order that they may function efficiently in carrying out the new laws, and in perfecting the various matters that must of necessity be either added to their duties or taken over by some additional organization.

If the question of compensation and working conditions is handled by a Government board, it would probably mean the cancellation of all present contracts, but if this is not done, contracts should be revised, with the idea of eliminating

many features that have crept into these contracts due to the manner in which the contracts were secured in early days from weak roads, and by precedent they have spread to many large roads. They were agreed to, evidently, by parties not familiar with operating economics or under pressure that they could not resist, and their existence has often prevented the consummation of operating economies.

The whole matter should be approached in a spirit of fairness to all, which means fair play to employes, fair returns to investors, and the lowest cost for transportation to the public that careful study and economical operation can produce.

Lateral Clearances.

Clearance in those parts of any mechanism which has a back and forward motion should always be sufficient to prevent any possibility of restricted action to the piece, otherwise stroke adjustment, wearing of the parts, or other unlooked for causes, may result in fouling. There is no practical virtue in cutting clearances too fine, although there are undoubtedly situations where the minimum amount of clearance must be worked to. Probably in the majority of cases adjustments could be made to rectify clearance discrepancies, but even if this is possible, it is not a procedure to be recommended, because any adjustment that has been given the part is in all likelihood there for some other definite reason, and the misuse of this may absolutely upset everything when the need for legitimate adjusting has to be carried into effect. In some cases these existing allowances cannot be tampered with, without creating all round trouble and a disturbance which may involve considerable risk in the liability of overheating and injuring the working parts.

New York Central Magazine

The New York Central Magazine makes its initial appearance this month, and will be delivered to all of the employes on the first of each month. It will be devoted to the interests of the employes of the road, their families and communities, and in the interest of efficient service. Various publications and announcements hitherto published from time to time and distributed to the forces will be consolidated in the new publication. Personal notes covering the activities of the workers, in addition to reports of operation, traffic, safety and other departments will be presented, including space devoted to women workers. In brief, it promises to be a reflex of the industrial, social and intellectual activities of the workers themselves. Pitt P. Hand, Editor, Grand Central Terminal, New York.

Purimachos—A Durable Cement

Among recent introductions in America in fire cement is an English production known as Purimachos. From reliable authorities it has been shown to withstand greater heat than that required to fuse iron. It is claimed to double the life of fire-brickwork. Though established in its reputation in England for a number of years it is not as well known in this country as in Great Britain where it has won an enviable reputation. It is in great demand in the British Navy and other departments, and various public works including railways and power plants. It is claimed to be of great value for promptly and economically building and repairing structures of all kinds exposed to flame heat. It is undoubtedly more economical than fire-clay, because its greater degree of efficiency and durability prolongs the life of the brickwork to an extent which far more than compensates for its initial cost. In the arches of boiler furnaces it has been found to be particularly serviceable and unlike fire-clay, which shrinks when first heated, the new fire cement slightly expands, and then sets perfectly hard. Used simply as a wash it imparts a glazed surface to the covered parts, greatly protecting the brickwork from the action of the flame.

The product appears in three forms. In the plaster form it is used for glazing, and for work where color is of importance, when dry color-matter is mixed with it for matching the surroundings. This is a white cement. The dark cement, of equally fire-resisting quality to the white cement, but lighter in weight and preferred for ordinary work, and lastly in the powdered form a refractory preparation for mixing with dark cement for resisting intense heat, and cannot be used alone, the dark cement being the bond which gives solidity to the mixture when set.

The varying temperatures require various mixtures of the cements ranging from a temperature up to 1500 deg. Fah., requiring only the pure cement, with varying mixtures up to a temperature of 2400 deg. Fah., where one part cement to four or more parts of powder is used to advantage. The latter mixture has been especially enduring for the brickwork of furnaces, not only in repair work but in coating the surfaces of the fire-bricks, which protects the joints and surfaces of the brickwork from the action of the flames. The cement in its various degrees of mixture should be found to be of great economical value in the various uses to which fire-brick is used in railroad appliances.

In this connection it might be remarked that while the brick arch as used in the modern high-powered locomotion has reached a degree of pe fection that would be difficult to surpass, it is well known that the central sections of the brick arch are more subject to decay, as whatever variations there may be in the temperature of the flame, it is usually more intense nearer the center of the fire. Frequently only a single section of the bricks need be removed, and as these sections have been diminished in size the cost is not great, but as the rapid decay of the central bricks unquestionably affects the equality of the flame, the prevention of this premature decay would be greatly delayed by the application of the cement with the layer mixture of powder already referred to.

The later introduction of the product, especially in American railroad service, will be watched with interest, and to those interested it may be stated that fuller information may be obtained from Messrs. W. A. Ross & Bro., 11 South William street, New York City, who are the agents for the product in America.

Joint Responsibility.

There can be no arbitrary reduction of wages to the pre-war basis. Were such folly attempted, employers would suffer as much as employees, and capital as much as labor. That there will be a gradual readjustment is inevitable, but we should remember that for every loss there is some compensation. If wages are gradually lowered there will also be an accompanying reduction in prices; consequently, labor will lose none of the just advantages gained during the war, and of which no far-seeing employer would desire to deprive labor. But labor must accept its readjustment of dollar value like the rest of us.

Let us hope that America will be so busy from now on that peace production will be great enough to maintain wages at a high level. And let us hope also that employers and wage-earners will carry into the transition period and into the future for all time the realization, awakened by patriotism during the war, of their joint responsibility, and that they will perceive the wisdom and the blessings of industrial peace. The spectacle afforded by Russia today ought to be a lesson of what any other course may develop.—*Francis Sisson.*

Cleaning and Oiling Belts.

Belts that have become too greasy and dirty should be cleaned with gasoline, then scraped and afterward wiped with a brush. In dry, dirty places it is good practice to brush them occasionally with a broom or stiff brush. Fish oil and tallow are used successfully in some shops to prevent slipping, and it is good practice to apply these lubricants on a new belt before using.

Items of Personal Interest

W. C. Barr has been appointed general foreman of the roundhouse on the Erie at Meadville, Pa., succeeding H. C. Eck, resigned.

John Clay has been appointed roundhouse foreman on the Erie, with offices at Dunmore, Pa., succeeding E. W. Jackson, assigned to other duties.

C. L. Nash has been appointed general storekeeper of the Mobile & Ohio, with headquarters at Tuscaloosa, Ala., succeeding T. A. Edgell, transferred.

I. W. Rector has been appointed chief despatcher of the Southern railroad lines, Richmond division, Vice Joseph Byrd, granted leave of absence on account of sickness.

C. H. Dyson has been appointed fuel agent of the Baltimore & Ohio, Western Lines, the Dayton & Union, and Dayton Union railway, with headquarters at Cincinnati, Ohio.

W. F. Kaderly has been appointed superintendent of motive power of the Southern Railroad, lines east, with headquarters at Charlotte, N. C., succeeding E. C. Sasser, resigned.

J. L. Carver has been appointed engineer of tests of the Illinois Central and the Yazoo & Mississippi Valley, with headquarters at the Burnside shops, Chicago, succeeding W. W. Kramer, deceased.

C. L. Bunch, formerly shop superintendent of the Southern at Spencer, N. C., has been promoted to master mechanic of the Memphis division, with headquarters at Sheffield, Ala., succeeding I. W. Gibbs.

C. W. Galloway, federal manager of the Baltimore & Ohio, Eastern Lines, and associated lines, with headquarters at Baltimore, Ohio, has had his jurisdiction extended over the Morgantown & Kingwood.

J. L. Donnley has been appointed roundhouse foreman of the Chicago, Milwaukee & St. Paul at Madison, S. D.; R. E. Bronsard at Athens, Ia ; E. W. Hopp at North McGregor, Ia., and W. Woodman at Rapid City, S. D.

James Carney has been appointed general foreman in the machine shops of the Erie at Newburgh, N. Y. J. Blackburn, night roundhouse foreman, at Jersey City, N. J., and R. E. Line, roundhouse foreman at Kent, Ohio.

Charles W. Yeamans, assistant engineer of the Chicago & Western Indiana, has been appointed purchasing agent of that road and the Belt railroad of Chicago with headquarters at Chicago, succeeding R. Bensen, transferred.

A. L. Graburn, formerly assistant superintendent of rolling stock of the Canadian Northern, with office at Toronto, Ont., has been appointed general fuel agent of the Canadian National Railways, with office at Toronto.

W. C. Lincoln has been appointed engineer for the National Railway Appliance Company, New York. Mr. Lincoln was previously associated with the General Electric Company, and later with the Railway Improvement Company as electrical engineer.

Captain George Post, Jr., of the Ordnance Department, has received an honorable discharge from the military service and has returned to the service of the Standard Coupler Company, as assistant to the president with headquarters at 30 Church Street, New York.

SAMUEL M. VAUCLAIN

E. E. Romey has been appointed superintendent of fuel and locomotive performance on the Baltimore & Ohio, eastern lines, the Coal & Coke Railway, the Wheeling Terminal, the Western Maryland, the Cumberland Valley, and the Cumberland & Pennsylvania.

P. T. O'Neill, formerly general foreman of the Tacoma, Wash., shops of the Chicago, Milwaukee & St. Paul, has been appointed division master mechanic on the same road, with office at Spokane, Wash., succeeding Fred Lowert, who has been transferred to the Tacoma shops.

J. Kilsm has been appointed general foreman of the machine shops of the Erie at Brier Hill, succeeding T. E. Cullen, promoted to assistant master mechanic; J. Millaney, roundhouse foreman, and W. Tracht, night roundhouse foreman, all with offices at Brier Hill.

Lieut.-Col. R. P. Lamont, president of the American Steel Foundries, who has been engaged for the last year as assistant to Col. McRoberts, head of the procurement division of the Ordnance Department, has resumed his duties as active head of the American Steel Foundries.

George W. Ditmore, assistant car builder of the Delaware & Hudson, has been appointed master car builder of the same road and also in the same capacity in the Greenwich & Johnsville, the Wilkesbarre Connecting, and the Schoharie Valley railroad, with headquarters at Colonie, N. Y.

I. A. Workman, formerly storekeeper of the Baltimore & Ohio Eastern Lines, with office at Keyser, W. Va., has been appointed storekeeper of the Maryland district, with headquarters at Camden Station, Baltimore, Md., succeeding O. V. McQuillan, deceased.

Samuel M. Vauclain, first vice-president of the Baldwin Locomotive Works, has had the honor of receiving from the French Government the title of the Chevalier of the Legion of Honor. This order of merit was instituted by Napoleon in 1802, all previous French military or religious orders having been abolished at the Revolution. It is the reward of at least twenty-five years of meritorious service.

J. W. Ryan, assistant secretary of the Pressed Steel Car Company, has been transferred from the New York to the Chicago office of that company, and Huntly H. Gilbert, returned from war service, where he held the rank of major in the Ordnance Department, has re-entered the service of the above company and the Western Steel Car & Foundry Company as assistant manager of sales, western district, with office at the People's Gas Building, Chicago.

H. C. May, general manager of the Monon, has been appointed federal manager of Chicago, Indianapolis & Western and the Cincinnati, Indianapolis & Louisville railroads. Mr. May is a graduate of Purdue University in the 1902 class of engineering, and entered railroad work in the same year, and was rapidly promoted in the mechanical department of the Louisville & Nashville, and served for several years as superintendent of motive power for the Lehigh Valley road. Mr. May returned to the Monon in June, 1918, and when the roads were placed under Government control he was appointed general manager of the Monon. He ranks as one of the most efficient railroad men in the West. It may be added that he is the son of Walter May, who is at present master mechanic of the Big Four and Chesapeake & Ohio, at Louisville, Ky.

E. S. Nicholas has been appointed traveling engineer for the American Arch Company at Detroit, Mich., R. M. Smith at St. Louis, Mo.; H. Darby at St. Paul, Minn.; J. D. Brandon at Montreal, Canada, and E. T. Mulcahy at Denver, Colo. Mr. Mulcahy was previously employed as traveling engineer for the company, but has been absent in active service in the United States Army during the last year.

Arthur F. Braid has been appointed sales manager of the metal and alloy department of the Metal & Thermit Corporation. Mr. Braid went to the company seven years ago as a traveling salesman, and after a few years of service in this capacity was appointed assistant superintendent of the Jersey City plant, in charge of the manufacture of carbon-free metals and alloys. When the United States entered the war, he assumed active charge of the metal sales at the New York office of the company.

Huntly H. Gilbert, who left the service of the Pressed Steel Car Company and Western Steel Car & Foundry Co. at the start of the war to enter the Army as Captain in the Ordnance Department at Washington and later commissioned Major and transferred to the Rock Island Arsenal, has re-entered the service of the above named companies as Assistant Manager of Sales, Western District, located at No. 425 People's Gas Building, Chicago, Ill.

JOHN S. Y. FRALICH.

John S. Y. Fralich has been appointed resident engineer of the Western District, Westinghouse Air Brake Company. Mr. Fralich served an apprenticeship as machinist, and was employed as machinist at the Altoona machine shops of the Pennsylvania railroad. In 1904 he was engaged by the Westinghouse Air Brake Company and assigned to the inspection force, and rapidly promoted as shop inspector, special inspector, and latterly with the experimental test department as supervisor of shop tests, acting as assistant to mechanical engineer. Appointed assistant resident engineer, which position he held until appointed resident engineer as above noted.

C. C. FARMER.

C. C. Farmer, until recently assistant Western manager and resident engineer for the Westinghouse Air Brake Company, has been advanced to the position of director of engineering in the same company. His rare combination of inventive ingenuity, engineering skill, practical shop and road experience, and complete knowledge of the proper correlation between manufacturer and railroad qualifies him unusually well for his new work. Mr. Farmer has been prominently connected with the development of the ingenious air brake contrivances now employed on modern long electric locomotives, as well as many other devices in steam and electric railway service; by his analytical methods, has discovered the source of many air brake troubles, such as undesired quick action, which had baffled the leading air brake experts for decades; and has instituted shop practices which are still in extensive use. Mr. Farmer served an apprenticeship as a machinist on the Southern Pacific Railway, and began, in 1891, a study of brake action and train control, in the Westinghouse Air Brake Company Instruction Car, on various roads throughout the country. In the same year, the Missouri, Kansas & Texas Railway Company offered him the position of supervisor of air brake repair, from which he was advanced in a few months to air brake inspector of the entire road. His commendable work with this organization attracted the attention of the officials of the Central Railway of New Jersey, who, in 1896, offered Mr. Farmer the position of general air brake instructor, which he accepted. When the need arose in the Westinghouse Air Brake Company for an inspector, with outstanding air brake ability and with wide road experience, Mr. Farmer was called there in that capacity. Not long after his second association with the Westinghouse Air Brake Company, he was transferred to the Chicago District as mechanical expert. Then he was appointed resident engineer and later, with the understanding that he would still retain the title of resident engineer, he was made assistant Western manager, from which dual position he has now been advanced to that of director of engineering.

In Memory of Dr. Angus Sinclair.

H. H. Vreeland, ex-president of the New York Railroad Club, paid a warm tribute to the memory of our late editor-in-chief, Dr. Angus Sinclair, in the course of which he stated that "since the last meeting of the organization we have lost by death one of the oldest, if not the oldest, member of this organization. When I became a member of the New York Railroad Club in the eighties, the members were holding their meetings in a small room in 31st street; and the towers of strength of this organization in those early days were such men as Forney, Sinclair, Brady, Snow, Hill, West, Blackall, and many of the older members of the organization who have since passed to the Great Beyond.

In the death of Angus Sinclair on New Year's Day, this club has lost a member whose work for the organization will long be remembered by all of the older and many of the younger members of the club. Mr. Sinclair's regular attendance at meetings and the many talks he has made to this organization both here and in the old quarters have always been an inspiration. The most technical, mechanical details were reduced to simple every day language with his direct and simple way. Mr. Sinclair was an inspiration both in his life, character and work to all of the members of this organization. His writings will be quoted and add strength to every man interested in the mechanical and general departments of railroad organizations. I recall when we were a struggling young club down in 31st street that Mr. Sinclair was always prompt in attendance and always ready to speak in the interest of the club and always ready to write for the interests of this club. He was a strong and forceful character and his life work will live many, many years after we have passed on."

On motion the secretary was instructed to prepare a memorial of the life and work of Dr. Angus Sinclair to be spread upon the minutes of the meeting.

Railroad Equipment Notes

The American Locomotive Company is reported taking an order for two 19-ton Mogul type locomotives for Portuguese East Africa.

The Pennsylvania Equipment Company, Philadelphia, Pa., is in the market for ten 30 cu. yd., 50-ton capacity steel automatic air dump cars.

The Canadian National Railways have ordered 100 colonist and 30 baggage cars from the Canadian Car & Foundry Company, and 50 colonist cars from the Pullman Company.

An official report to the State Department announced that the French and British authorities have assumed control of all railroads in European and Asiatic Turkey, in accordance with the terms of the armistice.

The Canadian National Railways have ordered 25 Pacific type locomotives from the American Locomotive Company, these locomotives to have 23½ by 28 in. cylinders and a total weight in working order of 260,000 lbs. each.

Robert Hudson, Ltd., Leeds, England, have ordered two Mogul type locomotives, weighing 37,000 lbs., and with 11 by 16 in. cylinders, from the American Locomotive Company, for service in Portuguese East Africa.

The Province of Santa Fe Railway (Cie. Française des c. de f. de la Province de Santa Fé), Argentina, has placed an order with the American Locomotive Company for 20 Pacific type locomotives; weight, 105,000 pounds; cylinders, 16x20 ins.

The Railways in Siam have apparently suffered severely during the war, because of their inability to procure steel equipment necessary to maintain their efficiency. Advices are that they are in the market for iron framework, wheels, and other parts.

In Iceland a railroad is planned from Reykjavik with the possibility that the ninety miles of line will be constructed by the state. Power development of the River Thjorsa, now being considered, would permit electrification of the proposed railway.

The Hershey Cuban Railway advises that it is in the market for a number of light passenger cars for branch line service, either storage battery or gasoline, with a seating capacity of from 30 to 50 passengers. H. L. Hill is manager of the company, with headquarters at Prado 33, Havana, Cuba.

The Bettendorf Company, Bettendorf, Iowa, has received an order from the Chicago, Milwaukee & St. Paul for 1,000 steel center sills for use in the construction of 1,000 40-ton capacity box cars which the St. Paul is planning to build in its Milwaukee shops.

In regard to the proposed Bagdad railway, the Taurus mountains were opened for broad-gauge traffic in November and trains can run now as far as Nisebin, a hundred miles west of Mosul. The probable time required to complete the line to the Persian Gulf is about two years.

The Canadian National Railways have ordered 750 box cars, 300 general service cars, and 250 ballast, from the National Steel Car Company; 500 stock cars and 150 refrigerator cars from the Canadian Car & Foundry Company, and 500 flat and 500 general service cars from the Eastern Car Company.

The South African Railways have ordered 40 Mountain type locomotives from the American Locomotive Company, 20 with weight of 200,000 pounds and cylinders 22x28 ins.; 20 with weight of 195,000 pounds and cylinders 22x26 ins. It is understood that these engines will be built at the company's Montreal plant.

The Illinois Central has awarded a contract to the Railroad Water and Coal Handling Company of Chicago for the construction of a complete pumping installation at Bois, Ill. The pump house will be of brick and concrete and the pumping equipment will consist of duplicate installations of 30-hp. oil engines with centrifugal pumps.

According to a Reuter telegram from Constantinople the British military authorities have taken over the working of the Baghdad Ry., and the Swiss general manager, M. Huguenin, has left for Western Europe. This railway is not likely to pass from British control for some time, if ever. The French have assumed control of the Orient Railway in Turkey, and they are not likely to part with it.

The South African Government Railways have ordered 40 Mountain type locomotives from the American Locomotive Company and 30 of the same type from the Baldwin Locomotive Works. Of the 40 ordered from the American Locomotive Company, 20 will have a total weight in working order of 200,000 lbs., and 22 by 28 ins. cylinders, and 20 will have a total weight in working order of 195,000 lbs., and 22 by 26 ins. cylinders.

The United States Railroad Administration is shipping locomotives to the principal railroads in America at the rate of about 150 per month, the bulk of which is nearly equally furnished by the American Locomotive Company and the Baldwin Locomotive Works. In the matter of cars of the various standards about 6,000 per month are being constructed and placed in service. Among the locomotives the Mikado seems to be mostly in demand.

The Belgian commission which is investigating the damage done by the Germans to railroads in occupied territory, while it has not yet finished its work, is in a position to give interesting figures relative to the destruction caused by the Germans. The figures show that nearly 690 miles of railroad tracks were destroyed and nearly 260 miles made useless out of a total standard gauge mileage of approximately 2,600 in Belgium. This destruction was mostly in the Mons coal valley in the region of Tourmal and around Ghent, Bruges, Ostend and Courtrai.

The Ryerson Scholarships

One of the Joseph T. Ryerson & Son Scholarships of the American Railway Master Mechanics' Association will be vacant in June, 1919. Candidates should make application to the Secretary of the Association in accordance with the conditions which have been established by a special committee. The scholarships provide an annual stipend of $300, and shall be continued for four years. The examinations will be held in June. Applicants must have at least twelve months' practical experience in the mechanical department of an American railroad. Details as to requirements and tests of subjects may be had from the Secretary, V. R. Hawthorne, 746 Transportation Building, Chicago, Ill.

Pulverized Fuel Equipment Corporation.

The Pulverized Fuel Equipment Corporation has been recently organized for the purpose of taking over the business of the Locomotive Pulverized Fuel Company, and to broaden the activities of the latter so as to cover the central power station, metallurgical and industrial fields. The head offices are at 30 Church street, New York City, with a Canadian office in the Transportation Building, Montreal. This corporation installs and delivers in operation complete plants of the "Lopuler" system for the preparation, distribution, storage, feeding and burning of pulverized fuel for any kind of steam generating or heating purposes whatsoever.

The development by the Locomotive Pulverized Fuel Company of its "Lopuler" system for the burning of anthracite and bituminous coals, lignite and peat in pulverized form has already commercially demonstrated its adaptability for not only steam locomotives, steamships, central power stations and other stationary boilers, but for furnaces generally and kilns. Many such installations are now in use and in course of construction.

The officers are: J. S. Coffin, chairman; J. E. Muhlfeld, president; H. F. Ball, vice-president, executive; H. D. Savage, vice-president in charge of sales; V. Z. Caracristi, vice-president in charge of engineering, and Samuel G. Allen, secretary-treasurer.

Graver to Increase Advertising for Coming Year.

The William Graver Tank Works, East Chicago, Ind., recently added an advertising department to its already extensive organization. This new department was made necessary by the rapid growth of the company during the last five years. R. T. Huntington, formerly manager of sales and advertising promotion for the Miller Rubber Company at Akron, has been appointed advertising manager. Previous to his connection with Miller, Mr. Huntington was associate director of the research department of *System*, the magazine of business. He has also had several years' editorial experience in both the trade paper and newspaper fields in New York, Minneapolis and Chicago. Graver advertising plans for the coming year include large copy in trade papers on the full line of Graver tanks, the Bartlett-Graver type K water softener and the Graver filter. This will be supplemented by an intensive direct mail campaign. The Graver company greatly increased its manufacturing facilities to handle large war orders, with the result that it now has one of the best-equipped plants in the country.

Rest Periods for Industrial Workers

The National Industrial Conference Board has published a highly interesting pamphlet of 55 pages on the above subject collected from data all over the world. The data are instructive but not conclusive. Some claim that a rest of 10 minutes induces an increase of speed of 16 per cent in the succeeding period. About as many claim that shorter hours are better. So it is that this pamphlet is like a flower from which the bee may extract honey, and the wasp may draw poison. We hesitate to pronounce on it, but if our opinion is worth anything we would rather keep our noses to the grind stone all day, and get away sooner at night. Copies may be had from the Industrial Conference Board, 15 Beacon Street, Boston, Mass.

Books, Bulletins, Catalogues, Etc.

Ludlum Steel, Published by the Ludlum Steel Company, Watervliet, N. Y. 100 Pages, Ornamental Cloth. With a Graphic Suggestion of the Relation Between Heat-Colors and Temperatures.

This work combines in a unique degree the qualities of an instruction book and catalogue. As is well known the Ludlum Steel Company is among the oldest high grade steel mills in America, dating from 1854, and are the pioneers in experiments in the use of electric furnaces and have used every known type of electric furnace and have developed a special form of furnace securing all the benefits common to the crucible in addition to the complete refining possible with the electric furnace. Hence the purity of the company's products. Practical scientific control has run into every channel of the operations in producing carbon and alloy tool steel. This is not all. In the making of tools from the best steel, the correct selection, the careful forging, the hardening and tempering are all vital elements to success. The book furnishes exact details of these operations. Experience will teach the thoughtful mechanic much, but this book will teach him everything because it is a reflex of many trained minds extending over many years. Other data of real value is appended, together with a general catalogue of the various classifications of the various steels, and their uses.

Proceedings of the Twenty-sixth Annual Convention of the Traveling Engineers' Association. Edited by W. O. Thompson, Sec., N. Y. C. R. R., Cleveland, Ohio, 478 Pages, Flexible Covers.

The transactions of the Traveling Engineers' Association convention held in Chicago, Ill., Sept. 10, 11, 12 and 13, 1918, appear in a fine volume. It may be recalled that in October, 1918, a condensed report of the proceedings appeared in Railway and Locomotive Engineering, but the volume before us furnishes complete details of the various reports together with the interesting discussions therein, and with the lists of officers and members and a reprint of the constitution and by-laws. The committees and subjects of discussion at the 1919 convention are also stated, and in this connection it is noteworthy to observe that there are only five subjects, all of importance to railway mechanical men, to be discussed. This assures the continuance of the excellent work of the association in a thorough discussion. Copies may be had on application to the secretary.

Railroad Electrification.

The Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., has issued a reprint from the *Magazine of Wall Street* an interesting article on "The Advantages of Railroad Electrification," by W. H. Easton. It is printed on toned paper and finely illustrated. It reviews in detail the improvements on the Norfolk & Western, the Broad Street station at Philadelphia, the trunk line electrification of the Chicago, Milwaukee & Western, with added details of electrified terminals and freight yards. Of particular interest is the decrease of the consumption of fuel. It is claimed that, figuring roughly for the entire United States, every mile of railroad operated by water power means a saving of 500 tons of coal per year. In the conservation of labor it is shown that on the Norfolk & Western the cost of repairs, retirements and depreciation, for handling 1,000 tons one mile, is 32 cents for steam locomotives and 10 cents for electrics. The outstanding feature of the article shows that while electrification is an expensive matter, it is justified by the advantages.

Graphite.

"Dixon's Graphite Products" is the title of a new pocket catalogue issued by the Joseph Dixon Crucible Company of Jersey City. While not so complete as the large general catalogue, it furnishes a good idea of the variety of products made by this old concern. Pages have been devoted to lists of articles especially for mills, railroads, automobiles, etc. The descriptions are brief, but the company will gladly send pamphlets dealing in detail with any of the individual members of the line. This new catalogue should be in the file of every purchasing agent, engineer, superintendent and others who have occasion to use lubricants, paint or pencils. Ask for Booklet No. 89-KP.

Fuel Facts.

The United States Fuel Administration has issued a new edition of a pamphlet giving information for consumers and savers of fuel. It is intended as answers to questions propounded in letters written from all parts of the country calling for information on fuel affairs and concerning the methods of fuel control. The whole subject seems to be taken up and discussed with absolute clearness, verified by statistics from the latest authorities, and is, perhaps, the briefest and best authority on the subject of fuel conservation hitherto published. Of special interest is the wide use of wood as fuel for what may be classified as domestic purposes. Copies of the publication may be had on application to the Educational Bureau, U. S. Fuel Administration, Washington, D. C.

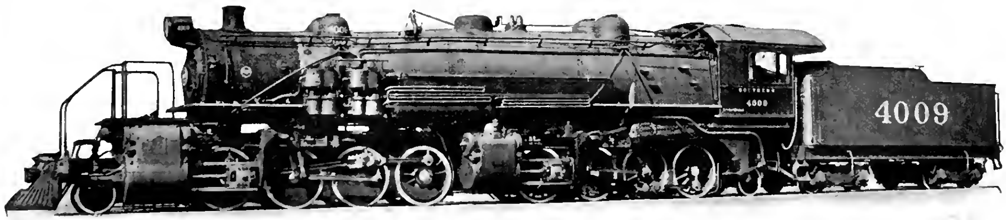
Railway and Locomotive Engineering

A Practical Journal of Motive Power, Rolling Stock and Appliances

Vol. XXXII 114 Liberty Street. New York, April, 1919 No. 4

Latest Mallet Type of Locomotive for the Southern Railway—Baldwin's Fifty-Thousandth Engine

It is interesting indeed to mark as if with mile-posts on a highway, the progress of a great manufacturing institution, illustrating, as it does, not only the result of careful management, but of wise administrative ability, and, above all, the demand for railroad equipment in the country in which we live. The Baldwin Locomotive Works were established in Philadelphia in 1831, and after eighty-seven years of constant progress the fifty-thousandth locomotive has recently been completed and is now in a group of twelve of the Mallet articulated type, with 2-8-8-2 wheel arrangement in operation in the Southern railway, and were specially designed for service on the Appalachia division, which extends from Appalachia to Bristol, Va., a distance of 69 miles. This division presents an undulating profile, with frequent grades of one to two per cent. The most difficult section of the line is between Philips and Mountain. From mile-post 57 to mile-post 65 southbound, the average grade is 1.7 per cent with a maximum, for short distances, of 3.4 per cent. This portion of the line is an almost constant succession of curves, many of them of over 10 degrees. Northbound there is a heavy pull out of Bristol yard for a distance of three miles. The grade here averages over 2 per cent with a maximum of 2.9 combined with frequent curves. The entire division has but few stretches of level track, and they are exceedingly short. The traffic on this division consists chiefly of coal, which can be economically moved in heavy trains at moderate speeds. Mallet locomotives are well fitted for service of this kind, as the required tractive force can be developed without using excessive wheel loads; and while the weight is distributed over a long wheel-base, the rigid wheel-base is short, so that curves can be easily traversed. As is common in this type of locomotive, this is accomplished by dividing the driving wheels into two groups, each group having separate frames, cylinders and machinery, and connecting the frames by a hinged joint. The boiler is held in rigid alignment with the rear frames and is supported on the front frames by sliding bearings. Economy in fuel and water consumption is obtained by arranging the cylinders on the compound system, and by the use of, as in the majority of Mallet locomotives, of highly superheated steam. The cylinders of the rear group of wheels act as the high pressure, and exhaust into the port cylinders, which are of larger diameter and thus act as the low pressure. Flexible pipes are necessarily used to convey the steam from the high pressure to the low pressure cylinders, and from the latter to the exhaust nozzle in the smoke-box.



MALLET TYPE OF LOCOMOTIVE FOR THE SOUTHERN RAILWAY.
Baldwin Locomotive Works, Builders.

With a total locomotive wheelbase of 56 ft., 3 ins., the rigid wheel-base is only 15 ft., 3 ins., or no greater than that of a Consolidation or Mikado type locomotive having the same sized driving wheels. Making compound the locomotive develops a maximum tractive force of 84,800 lbs.; and as the weight on the driving wheels is 374,000 lbs., the ratio of adhesion is 4.40. At starting speeds, the tractive force can be increased to a limited extent, if desired, by using live steam in all four cylinders.

The boiler barrel is composed of four rings, the second of which is conical, increasing the shell diameter from 80 ins. at the first ring to 94¼ ins., at the firebox throat. The longitudinal seams are butt jointed and sextuple riveted, and are welded at the ends. The main and auxiliary domes are located on the third ring, and the shell is re-enforced by a large internal liner which extends under both domes. The auxiliary dome is placed over an opening 16 ins. in diameter, so the boiler can be entered, when necessary, without dismantling the throttle rigging in the main dome.

The firebox has a combustion chamber

59 ins. long, extending forward into the boiler barrel. The seams in and around this chamber are electrically welded, and the boiler tubes are welded into the back sheet. A brick-wall, which serves to baffle and mix the gases, is built across the throat of the combustion chamber. The furnace equipment includes a Franklin power-operated fire door of the vertical pattern, and a Street "C" mechanical stoker. The grate rocks in four sections, and consists of table bars of the herring-bone pattern, which are supported on cast steel side and center frames. A four-hopper ash-pan, of large capacity is applied. Two of the hoppers are placed between the wheels, and the remaining two are placed right and left, under the rear end of the firebox and outside the wheels. The pan is fitted with wash-out and blower pipes, so that it can be easily emptied and cleaned. An air opening, five inches deep, is provided all around the firebox under the mud ring.

The steam dome is formed of a single piece of flanged steel 33 ins. in diameter. It contains a Chambers throttle, which has an external connection with the throttle lever. The superheater is of the fire-tube type, designated as type "A" by the Locomotive Superheater Company. It is composed of 42 units, and provides a superheater surface of 1260 sq. ft. The smokebox is of the self-cleaning type, and is equipped with a shut-off damper to protect the superheater pipes from over-heating when the throttle is closed. The valve gear is of the Southern type which is standard on the Southern railway system. The high and low pressure valve motions are controlled by a power reverse gear of the Ragonnet type, having an auxiliary steam connection. The pistons have steel heads, of dished section, with bearing-rings riveted on. Each piston has three gun-iron packing rings. The low pressure pistons have extended rods. The piston rods are bolted to the cross-heads instead of keyed. The front and back crossheads are interchangeable.

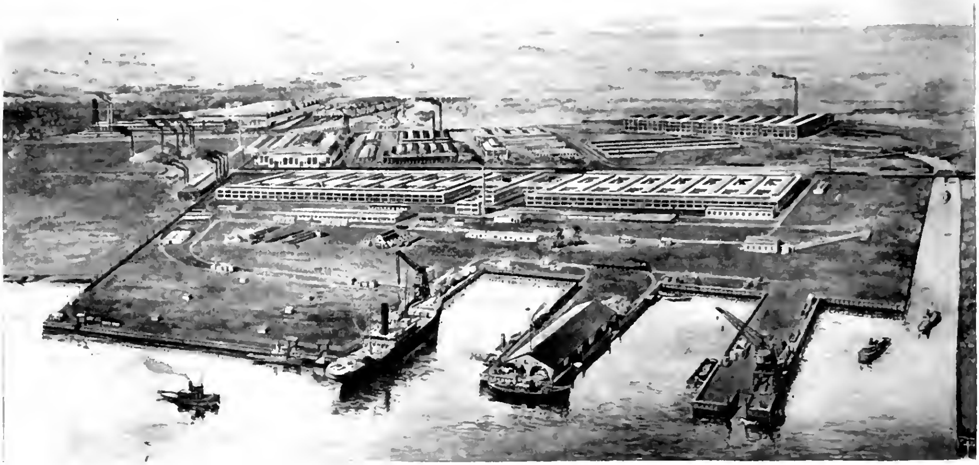
The articulated connection between the front and rear frames is designed in accordance with patents granted to the builders, and is a detail of interest. The tongue or radius bar, forming this connection, is attached to the front frames by means of a transverse horizontal pin. This pin is supported in a steel casting, which forms a strong transverse brace at the rear end of the front frames, and serves as a fulcrum, for the driving brake shaft. The rear end of the radius bar is attached to a vertical pin, which is mounted in a suitable pocket formed in the high pressure cylinder saddle. This pin passes through a case-hardened, spherical bushing, which is inserted into the radius bar. With this construction the front and rear frames can have relative movement in a vertical plane, when passing over uneven tracks or sudden changes in grade, without causing binding at the articulated joint.

The leading truck is center bearing and is of the Economy constant resistance type. The trailing truck is side bearing, the main driving boxes of both the front and rear group of wheels are of the Cole extended pattern. There are four sand-boxes, which are piped to deliver sand under the front and rear driving-wheels of each group. The by-pass valves are of the Mellin pattern, steam chest relief valves are furnished, and flange lubricants on the part of the driving-wheels of each group.

The tender is carried on equalized pedestal trucks, and has a built-up frame composed of 12 inch longitudinal channels with white oak bumpers. The engine and truck tender wheels are of forged and rolled steel, manufactured by the Standard Steel Works Company.

The following are the general dimensions of this locomotive:

Cylinders.—Diameter, H. P., 25 ins.; diameter, L. P., 39 ins.; stroke, 30 ins.; valves, H. P., type; piston, 14 ins. diam.; maximum travel, 6 ins.; steam lap, 1⅛ ins.; exhaust clearance, ⅜ in.; lead, ¼ in.; valves, L. P., type; piston, 14 ins. diam.; maximum travel, 6¼ ins.; steam lap, ⅞ in.; exhaust clearance, ¼ in.; lead, ¼ in. Boiler.—Type, conical; diameter at front end, 80 ins.; thickness of barrel sheets, 13/16 in., ⅞ in., 29/32 ins.; working pressure, 210 lbs.; fuel, soft coal; firebox, staying, radial; length, 132¼ ins.; width, 90¼ ins., depth, front, 85½ ins.; depth, back, 69 ins.; thickness of firebox sheets, sides, ⅜ in.; back, ⅜ in.; crown, ⅜ in.; tube, ⅝ in.; water space, front, 6 ins.; sides, 5 ins.; back, 5 ins.; tubes, diameter, 5½ ins. and 2¼ ins.; material, 5½ ins., steel; 2¼ ins., iron; thickness, 5½ ins., No. 9 W. G., 2¼ ins., No. 11 W. G.; number, 5½ ins., 42; 2¼ ins., 228; length, 24 ft. 0 in.; heating surface, firebox, 226 sq. ft.; combustion chamber, 109 sq. ft.; tubes, 4658 sq. ft.; total, 4993 sq. ft.; superheating surface, 1260 sq. ft.; grate area, 83 sq. ft. Driving-Wheels.—Diameter, outside, 56 ins.; diameter, center, 50 ins.; journals, main, 10 ins. x 22 ins.; journals, others, 9½ ins. x 12 ins. Truck Wheels.—Diameter, front, 33 ins.; journals, 6 ins. x 12 ins.; diameter, back, 33 ins.; journals, 6 ins. x 12 ins. Wheel-base, Etc.—Driving, 41 ft. 1 in.; rigid, 15



THE BALDWIN LOCOMOTIVE WORKS, EDDYSTONE PLANT.

ft. 6 ins.; total engine, 56 ft. 3 ins.; total engine and tender, 86 ft. 10¾ ins.; length over all, 96 ft.; width over all, 11 ft. 1½ ins.; height over all, 15 ft. 6 ins.; height, rail to center of boiler, 10 ft. Weight.—On driving wheels, 374,000 lbs.; on truck, front, 27,300 lbs.; on truck, back, 25,700 lbs.; total engine, 427,000 lbs.; total engine and tender, 603,000 lbs. Tender.—Wheels, number, 8; wheels, diameter, 33 ins.; journals, 6 ins. x 11 ins.; tank capacity, 9000 U. S. gallons; fuel capacity, 12 tons.

It will thus be noted that this type of locomotive may be said to fairly represent the most advanced that railroading engineering experience has produced to meet the particular service. All the modern improvements that have been specially approved have been applied in the construction, while the materials are of the best; and in closing it may be truly said that the Baldwin Works has since its establishment maintained this high reputation. Its growth, or development, or production, may be briefly summarized by noting as already stated that No. 1 locomotive was built in 1832; No. 1,000 in 1861; No. 10,000 in 1889; No. 25,000 in 1905, and No. 50,000 in 1918.

Numerically, therefore, the production of the past thirteen years has equalled that of the previous seventy-three years. The growth during the present century is great and, as may be expected necessitated the extension of the works beyond the Philadelphia plant. Accordingly in 1906, a tract of 184 acres was purchased at Eddystone, near Chester, Pa. This has since been increased until the tract now covers a total of 506 acres, of which 76 acres are under roof. A considerable portion of this plant has been used for the manufacture of shells during the war period, but are now being devoted exclusively to locomotive work. In addition to the locomotive shops, there are located on the Eddystone tract, two complete plants which were erected in 1915 and are owned by the Baldwin Locomotive Works. One of these plants is under lease to the Midvale Steel & Ordnance Company for the manufacture of rifles, while the other is under lease to the Eddystone Munitions Company, for the manufacture of ammunition. This latter company is wholly owned by the Baldwin Locomotive Works. The buildings comprising these works are so designed that they can, at the expiration of the leases be utilized as locomotive shops.

The accompanying illustration gives a bird's-eye view of the entire Eddystone plant. The large building in the foreground is the shop occupied by the Eddystone Munitions Company. The Eddystone plant has direct track connection with the Pennsylvania Railroad, the Baltimore & Ohio, and the Philadelphia and Reading railway; so that exceptionally complete shipping facilities both by rail and vessel are provided.

Considerable rearrangement and improvements have also been made of the Philadelphia plant, the rated capacity of the combined Philadelphia and Eddystone plants is 3,000 locomotives per annum, and the employes number 21,500. A further tract of 370 acres has been purchased at East Chicago, Indiana, so that the company is ready to place a new plant in operation.

Storage of Coal and Spontaneous Combustion

Analysis of Causes and Approved Methods of Suppression

Last month we took the opportunity to describe the storage of coal in the vicinity of New York and elsewhere, and while the spectacle was gratifying to us in common with others who had passed through winters when coal was scarce, it appears that S. H. Pudney, Fuel Inspector of the Canadian Pacific Railroad, was airing his views on the danger of the spontaneous combustion of coal when allowed to accumulate in large quantities. Many learned opinions have been advanced on the subject as to the causes, but like the peace of nations problem, the views are conflicting, and the end may be not yet. In any event Mr. Pudney brings to the subject of the spontaneous combustion of coal a wealth of experience, and has the happy faculty of putting in plain language the results of his real work which is not infrequently of more value than the most scientific speculations. In the presentation of his views he claims, to quote his own words, that despite the fact that the influence of sulphur in causing the spontaneous combustion of coal is disputed, I am of the opinion that it is the element of greatest danger in the storage of coal. By the word sulphur, I do not include that known as sulphur balls or true metallic pyrites. The sulphur in this form is very slow in its chemical changes, and known as sulphur balls or true metallic pyrites. The sulphur in this form is very slow in its chemical changes, and not enough heat would be set up during this change, in a given time, to do any harm to a coal pile; in fact, it would disperse as fast as generated without being noticed. There are other forms of sulphur in coal which are dangerous and the most vital one is that where the bone coal, and small pieces of shale, are full of sulphur. In this form it very easily becomes oxidised, even if out in the open air. It is only a matter of a few days before one will see the sulphur cropping out all over these pieces, like a fungus growth, whitish in color. At any place near where the coal is heating, to such an extent that fire is expected to show up, this is so extensive, that in some places the surface of the coal pile is covered with sulphur outcroppings, that has through oxidation and moisture, been brought to the surface. This is more noticeable in some coals than others, and my experience is that these are the coals that are liable to spontaneous combustion.

With our system of ventilation we often find some of the holes choked completely with sulphur, so that it is impossible to put down our test rods until the holes have been remade. In one place where heat had set up to such a degree that the coal had reached the stage of autogenous oxidation, we had the coal dug out and found that though actual fire had not started, the heat had so far advanced that destructive distillation had begun, and gases were being liberated from the coal even from the centre of large lumps. Here, I found the coal surrounding the actual hot place, full of these small pieces of shale and bone yellow with sulphur, and an analysis showed 6.7 per cent of sulphur while the average run of sulphur was less than 2 per cent. There is no doubt in my mind as to what was the cause of the coal in this spot heating, and in several more spots in the same pile I found the same conditions, and as this pile was heating in spots and not regularly all over the pile, no one who had seen this pile and the conditions that prevailed, could have arrived at any other conclusion than that the sulphur was the direct cause of the heating. However, the presence of sulphur in coal cannot be controlled as well these days as formerly, due to the labor conditions. Coal is not picked quite so clean as in former years, which is the reason that more fires have occurred lately.

The liability of spontaneous combustion due to a greater percentage of V. C. M. in the coal, does not hold water for one moment in actual practice; there are now

quite a number of authorities who disclaim this feature. I gathered this knowledge from the fact that some of the coal we were handling easily caught fire with 35 per cent of volatile carbonic matter, while others with over 40 per cent did not have the slightest tendency to heat up, and the peculiar part of it is that they had about the same percentage of sulphur, but that it was in a different form. Some authorities are of the opinion that spontaneous combustion is caused directly by the slow oxidization of the carbon content of the coal, and that the sulphur is only a secondary matter. If they were correct in such a statement, then we would be up against the proposition that all coal piles would be equally liable to catch fire, because all coal is chiefly composed of carbon, and its oxidation would be practically constant in all coal. Everyone that has had to do with storage of coal knows that some coals are more liable to heating than others, and this fact proves to the contrary the oxidation of the carbon theory. From my own actual practice, I am able to state that any fire that I have found has been caused by sulphur and not by oxidation and carbon. In places that have been dug out where the coal has been so hot that one could not hold it in the hand but had to hold it in a scoop to examine it, I found that the structure of the coal had not changed and was the same as when it was put in the pile, and yet there was bluish gas emanating from the piece of coal being examined. Now, if it had been oxidation of the carbon of the coal, which had caused the heat to set up, the structure of the coal would have been changed considerably before this amount of heat had obtained while, on the other hand, if one was to take a lump of coal and place it in an oven and heat to about 300 degrees and keep it there at that temperature, the same thing would be found, that the coal would be giving off a gas. In other words, destructive distillation would be started and this would be found to be not from the oxidation of the carbon content of the coal, but from the outside heat to which such coal had been subjected.

My own personal opinion is that sulphur is responsible for the trouble in coal piles. I feel that its rapid action in chemical changes is governed by the form in which it is contained in the coal. The power of fresh mined coal to absorb oxygen is well known, but there is doubt that the oxygen is contained in the coal, the same as water is contained in a sponge, and is a gas of occlusion and not chemically combined with the coal itself but held mechanically, and is given up to any chemical change that may occur which in this case is oxidization of the sulphur. The sulphur starts to oxidize, and in this action a certain amount of heat is generated. This heat again in turn increases the chemical energy, the increase in chemical energy raising the temperature. These changes dovetail into one another gradually, until sufficient heat is generated to start destructive distillation of the coal at the same time. At this temperature, the coal is hot enough to start self oxidation, or in other words, the stage of autogenous oxidation is reached. It is then only a matter of a few days till actual fire occurs with coking of the coal.

Some imagine that a system of ventilation allows the gases to escape, but as there are no gases to escape until the coal has reached nearly the point of fire, this cannot be right. Our experience is that with coal wet or even fairly moist and ventilated there is no danger at all.

There seems to be no set rules for fighting a fire, nor do I think there could be, because conditions are not always alike, but a few suggestions as what not to do may not be amiss. Fires in a coal pile burn very slow, for the simple reason that not enough air can reach the fire for rapid combustion. Therefore, never open up a fire spot. If the place is to be dug, dig close around it without touching the fire. Isolate it from the rest of the pile, then dig it out completely and drench it with water. It is one of the hardest things to prevent the inexperienced from opening up a fire. Fire will spread rapidly if opened up. Another thing very important, is that in using water on a coal fire, always saturate the coal surrounding the fire spot before putting water on the fire. If this is not done, the fire will be forced away from one faster than it can be reached. The reason for this is that the water going on to the actual fire, forces the heat into the surrounding coal which is nearly to the point of fire already, and at the same time it forms coke on the surface of the fire, into which it is impossible to force any more water, and meanwhile, the fire is still going ahead. It is absolutely ruinous to the rest of the pile to play water directly on to the fire, before putting a water screen around the outside of the fire spot first. It is very seldom that a direct application of water will put out a coal fire; and yet, I have put out a great many fires by application of water, after using the proper precautions, that is to say, by putting a water screen around the actual fire spot. At one time, with the assistance of two men, I put out a fire that measured 350 by 50 feet at its widest point and which would have practically gone through the 80,000 ton pile if it had not been stopped. This was done by finding the exact outer limits of the fire, then digging a shallow trench right along outside using water freely so as to put the water on the outside of the fire, then by systematically digging a relay of trenches coming nearer to the fire all the time we drove it to the outside of the pile and killed it completely. I might say that there was solid coke found to be six feet thick in this fire area, and the balance of the pile did not have to be touched.

Our mode of attacking a fire is to get our test rods, out around the spot and find out the exact dimensions of it, then find at what depth it is. We then dig a trench around this spot making sure to keep outside of the fire spot, saturate this with water and make holes with rods and see that a complete water screen is put around the fire, then, by a series of trenches gradually working nearer to the fire; we reduce this area until we cover the exact spot where the fire is, and making holes with our rods we take care to well flood it with water and it is very seldom we have to return to the spot as it is usually completely extinguished.

Recommendations on Piling of Coal.

BY THE NEW YORK HEATING AND VENTILATING SOCIETY.

Where there is choice of coal to be stored, that having the lowest oxidizing rate should be chosen, if known. Between two coals, that which is least friable, and therefore which presents the least total coal surface in the pile, should be selected. The method of handling should be such as to produce the least freshly broken coal surface. The coal should be as cool as possible when piled. Piling warm coal on a hot day is more likely to produce spontaneous combustion. The coal must be kept from any extraneous source of heat. Alternate wetting and drying of coal during piling is to be avoided if possible.

The fine coal, or slack, which furnishes the larger coal surface in the pile, is the part from which spontaneous combustion is to be expected. Piling of lump coal where possible is, therefore, desirable. In the process of handling, if the lump coal can be stored and the fine coal removed and used immediately, the practice prevents spontaneous combustion in coals which would have otherwise given trouble.

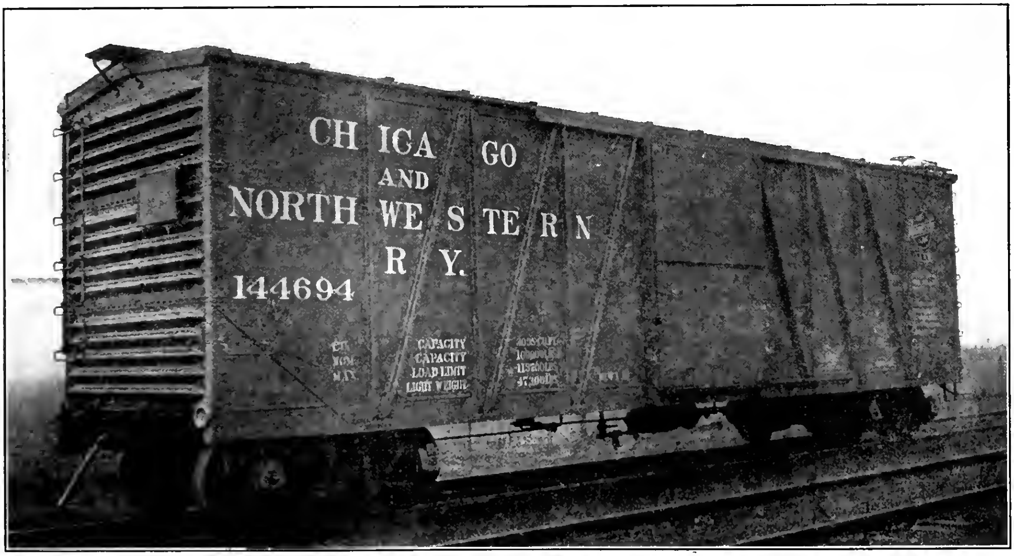
The sulphur content of coal is believed by many to play an important role in spontaneous combustion. The evidence on this point is still conflicting, but to play safe it is desirable to choose coal having a lower sulphur content when choice is possible.

There is a current belief that dissimilar coals stored in one pile are more liable to spontaneous combustion. The evidence on this point is also conflicting, but to play safe it is advisable to store only one kind of coal in a pile. The ground on which a coal pile is built should be dry.

United States Railroad Administration Type of Forty Ton Double Sheathed Box Car for the Chicago & North Western Railway

The box car which we have the satisfaction of showing our readers constructed January, 1919, is a car built by orders of the U. S. Railroad Administration and allotted to the Chicago & North Western Railroad.

It is lettered on the side as follows: Cubical Capacity, 3098 cubic ft.; Light Weight, 45,800 lbs.; Nominal Capacity, 80,000 lbs.; Total Weight, 132,000 lbs.; Maximum Load Limit, 86,200 lbs. The car is well built so as to fully meet the United States Railroad Administration requirements embodied in specifications and drawings for a car of this class, in supports are the special design of the Western Equipment Co. and center sills are the fish belly type with cover plates. The body bolsters are built up of pressed pan-shapes with upper and lower cover plates. Safety appliances are in accordance with United States requirements. The truck sides are the Andrews type, cast steel, manufactured by American Steel Foundries. The truck bolsters are made of cast steel, U. S. Standard design, and the brake beams are Simplex; Master Car Builders No. 2. The oil boxes are malleable iron manufactured by National Malleable Castings Co. The ing, causes additional weight and strength to be put in the side framing of the car, which tends to increase the weight of a car built of such height as these standard cars are, goes beyond that which is justifiable for a car of 80,000 lbs. capacity. The lower ends of posts and braces on a double sheathed car must necessarily be secured to the side sill or side sill framing in such a manner as to be somewhat insecure when compared with the more secure manner in which a car of the single sheathed type can have posts and braces secured to the side sill construction. The manner



U. S. STANDARD BOX CAR FOR THE CHICAGO & NORTH WESTERN RAILWAY.

so far as the kinds and qualities of materials which are used. It is equipped with the Murphy X L outside galvanized roofing, furnished by the Standard Railway Equipment Co. The ends of the car are of the Murphy corrugated design, handled by the Standard Railway Equipment Company and manufactured by the car builders, The American Car and Foundry Co. The draw bars are MCB type D, 6x8 ins. shank. The draw gear is the Sessions Standard Platform and Coupler Co. type. The air brakes are the Westinghouse K C 10-12. The Angle cock side doors and uncoupling device is that from Standard Railway Equipment Co. The side doors are manufactured by Union Metal Produce Co. and the uncoupling levers by the Material Appliance Company.

Some railways are not favorable to a double sheathed box car and it is often said that this is based on the following and other reasons, but the C. & N. W. car which we illustrate here is a single sheathed car. A car of the double sheathed kind with steel underframe and sides sufficiently strong to prevent bulg- in which a double sheathed car has the siding secured to the frame by nailing on the outside, with all internal pressures against it, tends to force it away from the frame and trouble has often been occasioned with cars of this class in having the sheathing or siding come loose from the frame. The floor in this car is 2¼ ins. in thickness and is not supported between the center sill and the side sill. The single sheathed car, here illustrated, is a serviceable vehicle and will no doubt give a good account of itself. It has a good business-like appearance.

The general dimensions are as follows: Length inside, 40 ft., 6 ins.; Width inside, 8 ft., 6 ins.; Height inside, 9 ft.; Length over striking plate, 42 ft., 1½ ins.; Width over eaves, 9 ft., 4 ins.; Width over all, 10 ft., 2½ ins.; Height from rail to top of car eaves, 12 ft., 10⅛ ins.; Height from rail to top brake mast, 14 ft., 1¾ ins.; Height from rail to top running board, 13 ft., 6⅞ ins.; Distance center to center of trucks, 31 ft., 1½ ins.; Height from rail center of coupler, 2 ft., 10½ ins.; Height from rail bottom of center sill, 2 ft., 4½ ins. This car has full, all-steel underframe, with fish-bellied centersills; steel reinforced super-structure, and is equipped with three-section corrugated, horizontal steel ends. It is also equipped with Carmer coupler release rigging, friction draw gear, and the trucks are equipped with anti-friction side bearings.

The Heavier Loading of Cars

By J. FRED. TOWNSEND, Traffic Manager, National Tube Company, Pittsburgh, Pa.

The improved car supply, which exists at the present time, has been brought about not only by the favorable weather conditions that prevailed throughout the mild winter, but by the lull in business following the signing of the armistice. These two conditions, with the heavier loading of cars, the propaganda for which has had the valuable aid and support of many shippers of steel products located in the Pittsburgh-Wheeling, Youngstown, Cleveland-Lorain, Birmingham and Chicago districts have combined to effect so marked an improvement that it may be thought it is less necessary to load cars to full carrying capacity. However, it should be borne in mind that a return to the old practice of light loading would speedily bring about another car shortage and congestion by reason of the increased number of cars necessary to carry a given tonnage.

Many shippers have volunteered the information that it is their purpose to continue to make the fullest use of equipment, maintaining records established during the war, regardless of the minimum prescribed by the tariffs, realizing apparently the advantages gained, which will prevent useless waste and return to the transportation conditions which formerly prevailed.

The United States Railroad Administration, through its Car Service Section, has recently issued an appeal to the shipping public, inviting attention to the accomplishments and the policy of the Railroad Administration with regard to freight car conservation, urging shippers to continue their efforts towards bringing about improved transportation conditions and pointing out that the cooperation of shippers has been a very material factor in compassing the following ends: "An increased car supply." "Lessened congestion on the railroads, particularly at terminal points." "Improved service made possible by such lessened congestion."

In this connection, it is interesting to know that the thirteen shipping companies of the United States Steel Corporation have conducted a vigorous campaign for the heavier loading of cars, and during the year 1918 the average carload shipments of these companies was 91,500 pounds per car. This is a remarkable showing when the fact is taken into consideration that the average marked capacity per freight car in this country is only 80,000 pounds, and it is hard to realize this record of heavier loading of cars when the average carload of all railroads throughout the country on all shipments, including the traffic referred to, was only 58,200 pounds per loaded car, or an average of 33,300 pounds per car less than the record made by the subsidiary companies of the United States Steel Corporation.

While the thirteen shipping companies referred to increased the average carload on outbound shipments during the year 1918 only 3,600 pounds per car, there was effected an actual saving of 63,828 cars, as compared with the loading for the year 1917, when the average was 87,900 pounds per loaded car. This does not include the thousands of cars loaded with iron ore by the Oliver Iron Mining Co.—also a Steel Corporation subsidiary—in its shipment of millions of tons forwarded during the year, all of which was loaded to the average of 50 tons per car. To include these would have tended to increase the average load, but would have been misleading.

Taking the average haul per ton of revenue freight throughout the country of the individual railroad as 166 miles, and the loaded freight cars per train as 25 cars, the railroads throughout the United States were saved 10,595,448 car miles, or 423,818 train miles; the 63,828 fewer cars used means that these cars were in other service and at the average freight revenue of 16.13 per cent the saving of this number of cars actually resulted in increased earnings to the railroads of $1,709,045.76 without any increased operating expense.

Taking the American Railroad Association method of counting every day in the life of a freight car as a "car day," the 63,828 cars saved by the thirteen shipping companies of the United States Steel created during the year 23,297,220 car days, and placing the average earnings of a freight car at $2.50 a day, and using its method of calculation, i. e., multiplying the number of car days by the average earnings per day, proves that during the year 1918 the railroads gained in gross earnings $58,243,050 by reason of the heavier loading of cars by these companies. And it means that the 63,828 cars saved were in other service, for there were no idle freight cars throughout the year.

Stated conversely, it means that the thirteen shipping companies actually forwarded 2,920,131 more tons of traffic than if the practice of loading one year ago had been followed, and this increased traffic was enjoyed by the railroads without any additional operating expense.

During the last seven years, the thirteen shipping companies of the United States Steel Corporation have increased the average carload from 69,200 pounds per car in the year 1911 to 91,500 pounds per car in the year 1918, an increase of 22,300 pounds per car, or 32 per cent, effecting a saving of 339,736 cars through the heavier loading of equipment, a record unmatched in this country.

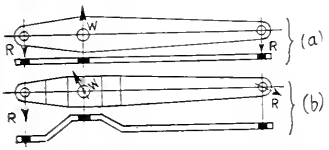
The railroads, consignees and shippers themselves have been greatly benefited in the fewer number of cars switched and weighed, to say nothing of the relief from congestion on the railroads, particularly at terminal points, improved service made possible by lessened congestion, and the great saving in operating expenses that was brought about by the fewer cars, both empties and loads, that were kept out of the various classification and interchange yards of the railroads from point of shipment to destination.

This record proves conclusively the real value of conserving freight car equipment at all times, and if the shipping public generally would note the enormous saving in equipment that has been created by these companies with only 32 per cent increase in the average load in the period of seven years, how much could be accomplished if all shippers would adopt the United States Railroad Administration's rule of loading to 10 per cent above the stenciled capacity, or to firmly fix the rule to load to 100 per cent of the carrying capacity whenever possible. The lesson that has been learned in the last year is worth remembering.

General Observations of the Design of Hanger Levers for Locomotives

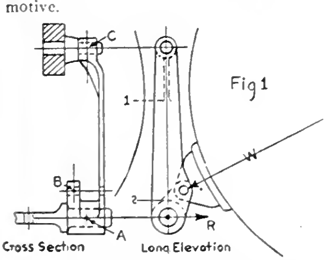
By VICTOR M. SUMMA, Engineer Examiner, American Brake Company.

The analysis of stresses in a plain flat-bar lever subjected to forces lying in the plane of the bar is one of the simplest operations in machine design. But if the lever instead of being straight as shown at (a) has one or two bends as shown at (b), and the forces on the pins are not only in different planes but are non-parallel to one another, then we may be sure that the problem of finding the stresses calls for considerably more thought than is usually given to such matters.



It is our intention in this paper to study the behavior of a type of levers, very much in use on locomotives, known as "Return Hanger Levers" and illustrated by Fig. 1 below, in the hope that the locomotive designer will appreciate the importance of the subject and allow it more space than he is wont to do in the general scheme of his work.

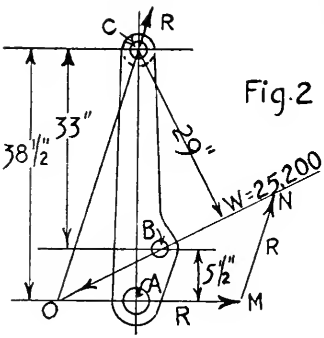
From the sketch it will be seen that, in order to clear the wheels, the lower portion of the lever carrying the brake shoe (as well as its top part) is several inches further in than the main body of the lever. For the same reason, the portion of the lever between points 1 and 2 is merely a flat bar, very often devoid of even the shallowest rib to prevent warping during annealing. It may be remarked in passing that, on account of this fact alone, such a lever is apt to be defective from the very start and that it should not be allowed on any machine, even less a locomotive.



The actuating force on the lever is applied at "A," the middle point of the journal bearing, and we shall assume, as is generally the case, that it acts parallel to the track with a certain intensity R. This force R is, or should be, so chosen that in no case will it cause at the brake shoes a pressure W greater than a certain fixed percentage of the weight on the drivers. This is necessary to prevent *skidding*. Experience seems to show, and many railroads insist, that for freight engines this pressure W—the so-called "braking power"—must not exceed 84 per cent of the weight on the driving axles, assuming a maximum pressure in the air cylinder of 70 lbs. per square inch of piston area and that for passenger engines these figures must be increased to 114 per cent and 95 lbs. In the present investigation we shall assume that the weight on the eight drivers of a freight locomotive is 240,000 lbs. The shoe pressure will then be

$$W = \frac{240{,}000}{8} \times \frac{84}{100} = 25{,}200 \text{ lbs.}$$

So "W" is our starting point, and one very easily arrived at. Now, by referring to Fig. 1, it will be observed that while the forces at A, B, and C do not lie in the same plane, still, so far as the motion of the lever in a longitudinal plane is concerned, which is, as one may reasonably call, the "plane of leverage," they may be considered as lying in the plane of the paper, where the longitudinal elevation is drawn. So that if the lever must be in equilibrium in this plane of leverage, it is necessary that the three aforesaid forces form a closing polygon. And since W (see Fig. 2) is known both in direction and magnitude, and R has already been assumed to be horizontal, the force R at C must pass through their intersection O. In other words, if the segment ON represents, to a certain scale, 25,200 lbs., and its direction meets that of R at O, and through N we draw NM parallel to line OC, then, to the same scale, the segment OM, or 19,000 lbs., represents R, and the segment MN, or 11,000 lbs., represents R. Or, by the theory of moments, since the perpendicular distances of C from lines OM and ON are 38½ in. and 29 in., we can check the value of R above thus:



$$R \times 38.5 = 25{,}200 \times 29$$

$$\text{or } R = \frac{25{,}200 \times 29}{38.5} = 19{,}000 \text{ lbs.}$$

It is important to notice here that the custom of taking 33 in. as one of the arms of the return hanger lever instead of 29 in. or the perpendicular distance of C to the direction of W (which is always radial to the wheel and not necessarily parallel to the pull rods), is not only wrong because unscientific, but wrong because it is bound to produce an excessive shoe pressure and the consequent result of the skidding of the wheels. By that method we would have had, for the force at the brake beam journals,

$$R = \frac{25{,}200 \times 33}{38.5} = 21{,}600 \text{ lbs.}$$

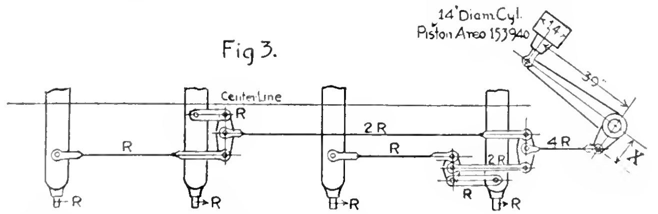
instead of 19,000 lbs., and the braking power would have been found to be:

$$W = \frac{21{,}600 \times 38.5}{29} = 28{,}600 \text{ lbs.}$$

That is, unconsciously, we would have produced 13.5 per cent more shoe pressure than that recommended by experience and thus defeated both the railroads' best intentions and our own. Skidding is expensive and special attention should be paid to this point. The same wrong method would be responsible for the failure of the pins at C. In fact, if W were parallel to R, the reaction R at C would also be parallel to them and equal to their difference. That is, we should have:

$$R = 25{,}200 - 21{,}600 = 3{,}600 \text{ lbs.,}$$

instead of 11,000 lbs. as given by the tri-



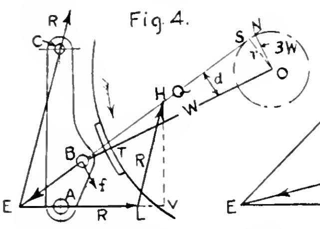
angle of forces of Fig. 2. In other words, without realizing it, the pin at C is actually carrying 7,400 lbs. more load than indicated by the old method, with stresses reaching sometimes as high as 45,000 lbs. per square inch.

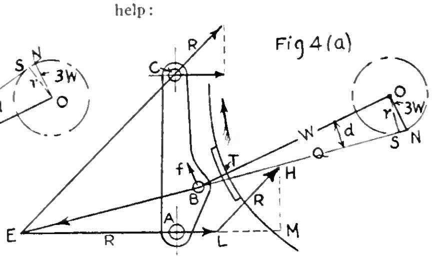
Figure 3 above illustrates the arrangement of a typical Brake Rigging for locomotives. It is reproduced here in order to point out the importance of choosing the proper figure for R in arriving at the toe-length X of the Cylinder Lever, if the proper shoe pressure is wanted. Taking, then, 19,000 lbs. as the value of R, instead of 21,600 lbs., we have by the principle of equality of moments:

$$X = \frac{70 \times 153.94 \times 39}{4 \times 19{,}000} = 5\tfrac{1}{2} \text{ in. (Approx.)}$$

So far we have made no mention of the shoe friction, in order that the preceding remarks could be better understood; but it is clear that the omission would tend to palliate rather than give undue emphasis to the badness of the results we are trying to correct.

Let us now introduce in our discussion this frictional resistance between wheel and shoe. It has been found that this force "f" reaches a maximum of 30 per cent of the normal or radial pressure against the wheel, or f = 0.3XW. The friction f (see Fig. 4 and Fig. 4 (a) below) acting tangentially at a point T near line BO, if not exactly on it, *reacts* at the brake-head pin B with an equal intensity; and, as it will simplify our work, we shall substitute for "f" and "W" their resultant, whose value is found thus:





Let the distance BO of pin B from the center of the wheel represent to a certain scale the value in pounds of the braking power W. Draw ON perpendicular to BO and equal to "f," or .3W. Then BN = Q represents to the same scale the resultant force desired. We have also from △BON:

$$Q = \sqrt{W^2 + (.3W)^2} = \sqrt{1 + .09}$$
$$= 1.044 \text{ W pounds.}$$

Moreover, by drawing the dotted circle OS tangent to BN at S and calling *r* its radius, we have, considering W, Q, and .3W as segments of lines instead of pounds:

$$r = W \sin = W \times \frac{.3W}{Q} = \frac{.3W2}{1.044W}$$

$$= \frac{.3W}{1.044} = .287 \times BO$$

Thus from the same diagram we gather that Q on the scale of forces is equal to 1.044 times the shoe pressure W, and that its direction is along the tangent to the circle OS (the so-called Friction Circle of Rankine), whose radius *r* is 0.287 (or approximately 0.29) times BO on the scale of distances.

So the problem is again reduced to the consideration of only three forces Q, R, and R_1; and for equilibrium of the hanger lever in the plane of leverage it is necessary, as before, that they form a closing triangle of forces.

The triangle ELH of Fig. 4 gives R and R_1 when the train moves in one direction, while the triangle of Fig. 4 (a) gives the values of R and R_1 when the train moves in the opposite direction.

It will be noted, now, that while the force R_1 of Fig. 4 (a) is considerably smaller than the corresponding value of Fig. 4, it still has an upward direction, showing that such a lever is always under tension no matter what the direction of motion is, a fact not generally understood. Vice versa, the force R of Fig. 4 (a) is considerably greater than the R of Fig. 4, indicating that in order to find the proper diameter of the pull rods it is important to use the value given by Fig. 4 (a) to prevent overstresses, another fact well worth keeping in mind. Hence the necessity of laying out both diagrams, independently of where the brake shoe is located with respect to the driver, in determining the size of parts.

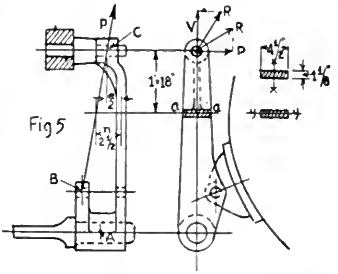
The following rule may be of some help:

"To find the magnitude and direction of the forces acting on a brake lever as a result of a pre-determined braking power W, draw from B the tangent BN to the friction circle at the center of the wheel of radius *r* equal to 0.29 of the distance of pin B from O, and produce it until it meets the direction of force R. Join this intersection, E, with the center of pin C. Then draw to some convenient scale the segment EH = 1.044W, and from H draw LH parallel to EC. The segments LH and HE to the same scale represent the required forces R and R_1 at the points A and C, respectively."

In our case, the distance BO being 36 ins., we have:

r = 36 × 0.29 = 10.44 inches.
Q = 1.044 × 25,200 = 26,300 lbs.
R = 22,000 lbs.
R_1 = 18,000 lbs.

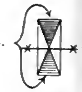
Then, with reference to Fig. 5, if the cross section to investigate is (a-a) (the one apt to give the greatest stresses), we observe that the force R_1 at the top pin causes:



First, a bending moment Pxl, where P, the horizontal component of R, in Fig. 4 (a) or LM = 4,000 lbs.; and l = 18 ins. Second, a bending moment P'Xn, where P' = component of largest value of R_1 along the direction of line BC, or P' = 17,600 lbs. approximately; and n = 2½ ins. Third, a pull V equal to the vertical component of the largest value of R_1, namely, V = 17,500 lbs. approximately. Fourth, a torsional moment Pxe, where e = 2 ins. and P the value given before.

Now, since section (a-a) measures 4½ ins. x 1⅛ ins., we have the following kinds of stresses per square inch:

(1). $\dfrac{4{,}000 \times 18 \times 6}{1.125 \times 4.5^2} = 19{,}000$ lbs.



in tension or compression along shorter side, remembering that $\dfrac{1.125 \times 4.5^2}{6}$ is the section modulus about axis (x-x).

(2) $\dfrac{17{,}600 \times 2.5 \times 6}{4.5 \times 1.125^2} = 46{,}500$ lbs.

in tension or compression along the longer side, remembering that $\dfrac{4.5 \times 1.125^2}{6}$ if the modulus of section with respect to axis (y-y).

(3) $\dfrac{17{,}500}{1.125 \times 4.5} = 3{,}460$ lbs. in tension only.

It is easy to see that this stress will add with the corresponding ones of the previous cases, giving as maximum stresses in tension:

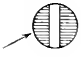
19,000 plus 3,460 = 22,460 lbs. for case (1) and

46,500 plus 3,460 = 49,960 lbs. for case (2)

(4) $\dfrac{4{,}000 \times 2 \times 9}{2 \times 1.125 \times 4.5^2} = 1{,}580$ lbs.

in shear, at middle of shorter side, remembering that 2/9 × 1.125 × 4.5² is the

polar modulus of section for stresses on short side; and



$$\frac{4{,}000 \times 2 \times 9}{2 \times 4.5 \times 1.125^2} = 6{,}320 \text{ lbs.}$$

in shear, at middle of longer side, remembering that $2/9 \times 4.5 \times 1.125^2$ is polar modulus for stresses in long side.

It is likewise clear that the 1,580 lbs. shearing stress will combine with the 22,460 lbs. tensile stress of case (1), since they are acting on the same particle of material and in directions perpendicular to each other. The same thing is true of stress 6,320 lbs. and 49,960 lbs. of case (2). But as we are after the maximum stresses the latter alone will be considered here.

So, using the well-known formulas

$$P_1 = \frac{S}{2} + S\sqrt{\left(\frac{S}{2}\right)^2 + S_s^2} \text{ and } P_2 = \sqrt{\left(\frac{S}{2}\right)^2 + S_s^2}$$

in which S and Ss stand for the tensile and shearing stresses, respectively, and P_1 and P_2 their maximum combined effects in tension and shearing, we have by substitution:

$$P_1 = \frac{49{,}960}{2} + \sqrt{24{,}980^2 + 6{,}320^2} =$$

$$24{,}980 + \sqrt{\frac{624000400 + 39942400}{663942800}}$$

$$P_1 = 24{,}980 + 25{,}760 = 50{,}740 \text{ lbs. maximum tension}$$

$$P_2 = 25{,}760 \text{ lbs. maximum shear.}$$

These last two figures seem to indicate that the hanger lever is unduly stressed, in tension as well as in shear, and that it would be liable to break almost any time. And the example here given is not by any means exceptional. As a matter of fact, since engineers, generally, stop their calculations with case (1), disregarding altogether the bending and twisting moments due to the offset n and e so that the stress would appear to be no larger than 19,000 lbs. per square inch or at most 22,460 lbs., there must be 90 per cent of the hanger levers on locomotives today that would show stresses fully as high as those given above by P_1 and P_2.

It is important to notice also that the bending moment P^1xn and the twisting moment Pxe are to a great extent counteracted by the resistance of the shoe and wheel-flange and that of the brake beam itself. Indeed, it is for this reason and for the fact that cast steel has an ultimate strength of 70,000 lbs. per square inch that the present failures of this type of hanger levers are not so alarming as the figures would indicate. But it is obviously wrong to put any reliance on these facts. First of all, the flanges of the wheels were not designed to resist the lateral thrust of hanger levers and their shoes, and, in the second place, the brake beams are mighty poor members when used as columns.

These results, it is hoped, will be sufficient to convince the locomotive designer of the necessity of providing enough space between drivers so that the designer of the brake rigging may be able to give him a more decent lever than he has done in the past. Five or six extra inches to the length of a locomotive is not, after all, so big a price to pay when a more efficient and safer way of stopping a train is not only the end in view but the actual result.

These suggestions are not intended so much to find fault with the present methods of construction as to suggest some improvement in details of some importance.

Approved Cooling Lubricants

An eminent authority claims that "sticky" water was the best cooling media for general purposes. Half a pound of soft soap to 1 gallon of soft water, with the possible addition of 3 per cent caustic soda, gave a very good general purpose emulsion for the usual machine shop. The amount of soap should be lessened in cold weather. Plain water splashed too fully, the addition of the soft soap beside its lubricating qualities increased the skin tension of the fluid, and caused more intimate adhesion of the fluid to work, chip and tool. There is considerable choice in the matter of soft soap; some is perfectly bland, some has the vilest odor and color imaginable. After all, it depends upon the initial ingredients, and whatever these are in a cutting emulsion, the oil must first be saponified to emulsify. In the case of soft soap made from good vegetable oil the first stage on the road to emulsification has already been performed. Caustic soda, if added, tends to prevent rust. From actual experience the present writer can testify to the lubricating powers of good soft soap solution. Submerged bath lubrication with a load not too severe (under 50 lb. per square inch) and without agitation, are conditions where a solution of soft soap and distilled water will give perfect results at a lower cost than oil. If a strong solution is first made, diluted to half strength for use, a daily addition of a small quantity of the strong liquor will rectify the fluid and prevent deterioration. For all practical purposes the fluid with the highest specific heat is the best cooler—in other words, water is better than oil in this connection. To get the best results from soft soap distilled or condensed steam water is far and away the best.

Reciprocating Engines.

The *Practical Engineer* states that the turbine has definitely become recognized as the most efficient type of engine for the propulsion of steam-driven ships, and many prophets go so far as to say that, in conjunction with double-reduction gearing, it will very soon entirely displace the steam reciprocating engine. With this view we are not disposed to agree; both on account of its greater reliability and because it is far simpler to manage it will long be utilized for the propulsion of tramp steamers and cargo vessels of low power, where engineers of the highest skill are seldom employed; and for this reason attempts will continue to be made to improve the efficiency of the reciprocating set. It is hardly likely that any fundamental changes will occur, but attention to details is often instrumental in bringing about a considerable economy in operation. One of the most important details, and one which is worthy of the closest attention of designers, is the arrangement of steam ports. With a view to reducing the clearance volume to a minimum, short straight steam ports at the ends of the cylinder can be employed in conjunction with a long valve, this having the additional advantage of reducing the internal surface, which is cooled by the passage of the exhaust steam, and upon which the incoming steam will condense. Again, the cylinder covers should make joint with the cylinder as near the face of the cover as possible, and the surface of cylinder cover should be kept as small as possible; in this way, while the clearance volume may be unaffected, the internal surface upon which steam may condense is again reduced to a minimum.

The Pershing Locomotive.

The "Pershing" locomotive, built on standardized plans designed by the United States Military Railways, has not only been made the sole type of steam locomotive in use behind the American lines in France, but, at the instance of the War Industries Board, has been adopted by the British and French Governments as the standard type for their armies on the western front.

Brass Castings.

When clear, yellow brass castings are desired, a mixture of 7 lbs. of copper, 3 lbs. of spelter, 4 oz. of tin, and 3 oz. of lead makes a good casting alloy and one which will cut clean and free, and is also strong. An increase in the amount of tin augments the strength of the alloy and also increases the degree of hardness.

French Railroads and War Making

By JOHN BURTON WOODS, Ex-Captain, United States Army

Before the World War, the region of France lying east of Chateau Thierry was much loved by tourists and consequently was well supplied with hotels. In one of the small towns there lived a man who manufactured ice on a large scale and supplied the surrounding country. Railroads reached throughout much of the territory, but they did not reach his plant. And for several years he persistently asked the state owned line to lay a spur a few kilometres to his town so that he and his neighbors could ship their products by rail. And just as persistently year after year the railroad people turned down his petitions, or smothered them in investigations and preliminary reports of engineers.

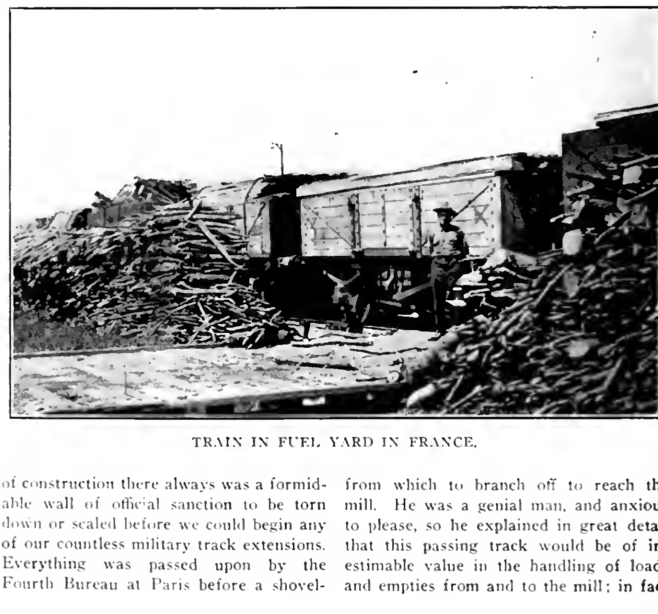
TYPE OF LOCOMOTIVES ON FRENCH RAILROAD.

Then came the war, when all civil activities ceased except as they could aid directly the military situation. And in 1918 the ice maker was driven from his home by the German offensive, leaving all his equipment behind. After several anxious weeks the counter-offensive gained back his home town, and he returned to look over the remains. He found the factory in good running order; apparently the Germans had seen fit to operate it for the benefit of their hospitals back in the rear. And stranger still, he found that they had actually constructed, and in their haste had left behind, the spur track that he had tried so long to get.

Now this is no brief for the Germans. The only reason they left either track or factory was the rapidity of the allied advance. But it was ironical that an enemy invasion was required to bring to a large French industry the railroad connection sustained by its product and the products of its neighbors. French business men shrug their shoulders and rant about official red tape when speaking of pre-war railroading, and yet in certain directions the war-time efficiency of her public carriers was nothing short of marvelous.

To the American, France's railroad establishment is a strange mixture of good and bad points. In the department of construction there always was a formidable wall of official sanction to be torn down or scaled before we could begin any of our countless military track extensions. Everything was passed upon by the Fourth Bureau at Paris before a shovelful of dirt could be moved, and preliminary plans for a thousand foot siding were subject to the same endless investigations and delays as were those for independent main line systems. Different roads had their hobbies of instal'ation, and they were adamant in the adherence to details of practise. For example, certain roads required that every siding built by Americans should be of the *demi-lune* type, or half-moon shape, with the actual spur turning out from the demi-lune. This meant the construction of a semicircular turnout, with switch at either end, and a third switch near the center of this track to lead away upon the spur to the desired loading place. Of course this was a safety measure and justifiable when the turnout was made from a main line with several trains daily. But out on the branch lines, where two trains each twenty-four hours was the maximum, the cost was greater than the safety value.

Up in Brittany an American officer and the local French Road Master were conferring upon a question of installation for a small sawmill. There was a deep gully alongside the existing track, and the mill site necessarily was upon the other side of this ditch. Thus a bridge was required, and the French engineer demanded also that the Americans should widen the main line dump and install a passing track



TRAIN IN FUEL YARD IN FRANCE.

from which to branch off to reach the mill. He was a genial man, and anxious to please, so he explained in great detail that this passing track would be of inestimable value in the handling of loads and empties from and to the mill; in fact

he implied that his only desire in asking for this extra construction was to render better service.

"All right," replied the American, "We'll put in the passing track. But why will it not be wiser to place it on the other side of the gully? There is plenty of room, the ground is level, and the cost will be less than a fourth that of building here beside the track. We can spur out from this main line, bridge the ditch, and find the necessary switching layout over there. Then we will spot the loads on the spur, your engineer can cut his train, back into them, couple up or cut again as the case may be, and kick the empties into the same position that the loads occupied. Or if you wish he can come into mill and do the thing more easily by using both tracks."

"Wonderful! I never had thought of that! I shall go at once to my chief and report your suggestion. It is so much the more economical solution, and cost is what we strive to reduce." He went and in a week he returned with a folio of opinions and instructions. "Your suggestion has been approved," said he with a pleased smile. "There is but one condition imposed by our Department. You may build the passing track across the ditch, but you must build also the other one here beside the main line!"

AMERICANS MOVING TRAINS ON RAILROAD IN FRANCE.

The French system of maintenance is based upon the pre-war cheapness of labor, and the peasant's love of official titles. Each line is divided into very small work sections, and each section possesses a dwelling house or *maisonette*. Here the workman lives with his family, and he watches the track within his jurisdiction. Repairs are made by the combined work of the men in several sections, with outside aid when it becomes necessary. But each section watcher has his title and badge, a comfortable home, and is zealous in the interest of his employers. All roads have been rock ballasted, the ties are treated except for white oak, and as a result the upkeep is remarkably low. The fact that France has kept her railroads operating with fair efficiency during four years of war, when materials for ordinary repairs both to track and rolling stock were practically unobtainable is sufficient evidence that her system was successful in the past and had produced a high state of perfection.

Germany got away with thousands of French cars at the outbreak of the war. Yet with the aid of Britain she met the demands of war and made good the military losses as they occurred. As a matter of fact it now has become known that the long lines of bad-order equipment found in every French storage yard were matched by similar strings in the railroad graveyards of the Central Empires. And in addition to her own needs France loaned a number of locomotives to the American Army.

The short and light car common to Europe has been the object of many a jibe since our men crossed to the other side. Particularly, the Yankee railroad man despises the link, hook and screw coupling arrangement. And he dislikes also the hand brake which has to be set for every car from the ground. But in a land where short haul freight is the rule, the ten ton car is more practical than that of forty tons capacity. Then too, wear and tear upon roadbeds are not so appreciable. And small cars are more easily handled in the yards than large. However, our army has introduced many cars of our own; some built in Spain, some in England, and some shipped from home, and these are almost without exception large flats and boxes, capable of carrying thirty to forty tons and more. The need was for a car that should travel between base ports and supply depots, relatively a long haul, and capacity was the main object. France had a few such cars before we came into the game, and her engineers admire ours so sincerely that their railroads probably will buy all we have over there. They are to be used for long haul traffic, of which there is a certain amount always to be handled.

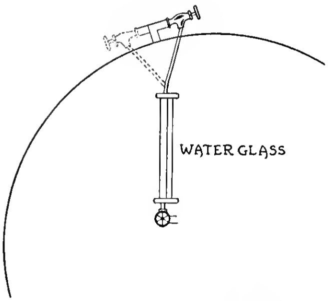
Of course operation is the final test of a railroad. And France has given examples of mixed character. Generally speaking, however, her handling of the roads during the war has been a remarkable success. Her private companies went under government control at the very beginning of war, and this control was strictly a military administration. Local freight and express suffered from time to time and passengers became inured to slow travel and crowded cars. But soldiers were able to journey at almost nothing and mail received prompt carriage almost always. And in the movement of her own troop trains she established a marvel among records. At one point in eastern France, during the rush of reinforcements to Italy to stop the disastrous drive of the Austrians, American officers counted more than one hundred troop trains passing over a given point in two days, all heading south. This was one type of passenger traffic that meant much to the hard pressed Italians.

And when our troops began to arrive in great numbers the roads of France took over much of the additional burden. In fact that is one of the most wonderful characteristics of her lines, they always were about to break down under the strain of traffic, and yet, throughout the four years of fighting, they always were able to keep going and assume greater burdens as new allies threw their men and goods upon the docks of her coast cities.

Rectifying Water Glasses on the Southern Railway.

By A. Howard, Alexandria, Va.

The Southern Railway, like most of the other large roads of the country, have had consigned to them recently a number of United States standard freight engines. Ever since they have been in service here on the Washington Division there has been serious complaint by the engineers



DOTTED LINES SHOW FORMER WAY ELBOW FITTING WAS TURNED, AND SOLID LINES SHOW PRESENT WAY.

running them that owing to the erratic action of the water glasses that it was impossible to tell the amount of water that was being carried in the boilers. This same trouble has been experienced by the engineers running these engines with water glasses of similar design on other roads.

The glasses are connected to the boiler at the top by a pipe from the glass to a cock that is fastened in an elbow fitting that screws into the boiler up on the curved part near the top. The opening in the elbow that receives the cock was turned down, thus forming a pocket at the pipe connection, where, when engine was standing condensed water would accumulate, causing an obstruction to the steam pressure from the top of the glass to counteract the water pressure from the bottom, making the glass indicate, at all times, a very much higher water level than was shown by the gage cocks.

Mr. O. C. Garr, who is running one of these engines, and who is of a persevering, energetic disposition, determined to ascer-

tain the cause, and if possible find a remedy for the erratic action of these glasses.

He found that by creating a leak where the pipe leading from the top of the glass connects to the cock, that was sufficient to allow the condensed water to run out; that the steam pressure from the top acted in harmony with the water pressure from the bottom of the glass, entirely eliminating the improper showing of the water level.

Mr. Garr explained his discovery to several other engineers here, and they brought this matter to the attention of the officials of the mechanical department, who upon investigation, found that by simply giving the elbow a half turn so that the cock would set towards the top of the boiler and adjusting the fittings in this position it allowed the condensed water to run back into the boiler which completely did away the fault.

These engines were designed by Government mechanical engineers. The enclosed drawing may help to illustrate what I have tried to describe, the dotted lines showing the former way that the elbow fitting was turned, and the solid lines showing the improved method of application.

SCARCITY OF COAL IN SWEDEN

Use of Powdered Peat on Locomotives.

By A. R. Bell, Bucks, England.

Owing to shortage of coal the Swedish Railway authorities have had to resort to substitutes for use on their locomotives. Wood and peat have been commonly used in the form of logs and briquettes, respectively. An interesting experiment has been tried with dry powdered peat.

The peat, after excavation from the bog, is delivered by tipping wagons on a light railway to a drying ground. It is then cut into briquettes by an electrically-driven cutter and then taken to special drying stoves. After being thoroughly dried the briquettes are carried on a conveyor belt to a grinding room for being converted into powder. The powder is stored in silos, from which it is discharged, as required, into trucks, each holding 15 tons, for conveyance to stores on the railway.

The process of burning the peat powder involves very little alteration to the firebox of the locomotive. The fire is started with coal and a thin layer of coal-fire is retained continually as a base for burning the peat powder. The proportion of coal required is about 3 to 4 lbs. to 100 lbs. of peat powder. The peat powder is fed through a nozzle by means of compressed air.

There are two disadvantages apparent, viz.: Tendency to spontaneous combustion in the storage reservoir, and an abnormal emission of sparks from the funnel of the engine. Spark arresters have been tried, but not successfully.

Locomotive Sparks

Methods of Suppressing Their Cause of Loss by Fire

As the warmer weather approaches, the danger from locomotive sparks increases, and it is well that attention should be occasionally called to this danger, which, although in a more limited degree than formerly, is still with us. The improvement in what may be called the fire prevention department of the railroads generally has been particularly marked and many of our cleverest engineers have given the matter serious attention, with the result that a systematic inspection of the parts of the locomotive looking toward fire prevention is being constantly made. Some time ago A. D. Brooks, of the Illinois Central, made an exhaustive study of the subject, and presented his views in an able paper from which we subjoin some extracts that may be useful as a reminder of the ways and means of reducing the danger to a minimum. Mr. Brooks stated that the locomotive spark hazard is considered one of the greatest sources of fire loss in railroad property. This is because company buildings generally are located within the range of spark showers from locomotives, together with birds' nests, poor shingle roofs and general repairs, in which crevices, open joints or decayed parts form pockets that catch the ashes liberated from locomotive smoke stacks and then ignite from other sparks.

A very wide study has been given to the hazard of locomotive sparks and the consequent fire damage that has been inflicted to railroad property along the right of way of railroads attributed to such cause. It has received special study and consideration by the motive power department, claim departments and those who have in hand the indemnity following the destruction of property either belonging to the railroads, or located in the vicinity of railroad right of way.

After such careful thought and attention by the departments of railroads vitally interested, it seems that we should get down to a positive means for eradication of the hazard, rather than the methods that have been pursued to lessen the result of the hazard. By the former, we mean that the principal place to offset this hazard is in the roundhouse and shops in keeping the screens, fittings, front end appliances, ash pans and dampers up to the standard as set forth in the blue prints and regulations heretofore issued and seeing that they enter service under such conditions. By the latter we mean methods to lessen the results of the hazard by corrections in construction of buildings, such as has been undertaken in the past through the substitution of a better class of roof coverings, avoiding unnecessary pockets in roofs of buildings for the accumulation of sparks, etc., cutting down of grass and weeds in the vicinity of railroad property, digging of ditches, cutting of divisions or avenues in timber tracts and the application of fire resistive coatings to woodwork exposed or subject to lodgement of sparks or hot coals; and by keeping the ties and stringers on bridges and trestles in good order.

While the conditions of front ends and ash pans may be classed as the primary causes of fires started by sparks or cinders, auxiliary causes are on account of engines running with their damper doors open or not entirely closed through carelessness of the engine men or cinder pit men. What may be termed secondary is the bad condition of shingle roofs, platforms, trestles, roofs of wooden cars, exposed inflammable merchandise in cars, rubbish about buildings where a spark may land and start a fire. If these auxiliary causes were taken care of the result through the primary cause would be reduced to a minimum.

The various motive power departments of the railroads, as well as the Master Mechanics' Association, have given the spark hazard a great deal of consideration and study and standards have been adopted and recommended for practice which, it is believed, would give generally satisfactory results and meet both the conditions of service and minimize the spark hazard. We have observed in connection with some of the large railroads of the country that severe service tests have been given through a period of years to develop better conditions and that the front end arrangements on locomotives or what is known as the "spark arresters," have been receiving careful constructive consideration. It is a question to forcefully draw the attention of this subject to every official, as we consider that the spark hazard is possibly the greatest that has to be contended with in connection with fires on railroad property and that even though through a period of years the losses from spark causes have been very much lessened in many instances, it is a question whether it may not be possible in the future to entirely eliminate the occurrence of fires from these causes. It seems to be a question for the master mechanics, shop and roundhouse foremen to solve this very important hazard by frequent inspection and careful maintenance, as we who are studying the prevention of loss by fire, must necessarily defer to a large extent any investigation of or judgment as to the

correction or elimination of the spark hazard and depending on those dealing more directly with the mechanical contrivances concerned. We find that the relative importance of the value of property destroyed shows that sparks from locomotives occupies about second place of all the sundry hazards involved in the destruction of railroad property and that in the number of fires reported, it occupies about the same relative position.

We believe, therefore, that the main point that we can emphasize at this time to be taken up by the officials is the development of the importance of the inspection of spark arresters and ash pans; not a haphazard inspection, but an examination of the screen to see if it is stripped or worn out; if the wires are spread, if the fittings around the sides, of manhole cover, the nozzle and steam pipes are tight; if the ash pan dampers, damper controlling devices and the extension of pan outside of mud ring are in good order; where not already done, to provide for a weekly inspection of all engines and that a duly authorized form of report be provided, on which the signature of the inspector making the examination is to be recorded and also for an inspection at the time any repairs are completed and the locomotive again turned over for road service with the corresponding signature of the inspector making the final inspection. In addition to this, we would recommend that efficiency committees be authorized to check up the work of inspectors in this respect. We also recommend that whenever fires occur on or near right of way from alleged sparks from locomotives that a report be immediately made of the condition of the spark arresters and ash pans of the locomotives passing the location several hours prior to the fire and that such report be checked against the last weekly inspection of these engines. We also recommend that the following instructions be issued as a systematic method of dealing with the subject.

"Master mechanics and enginehouse foremen should see that all locomotives are properly inspected after each trip, and that any defects in ash pans or ash pan gear are properly reported on special form for that purpose and repairs made.

"Weekly or at staybolt or boiler wash period, the front end of locomotive must be opened and examined and a special examination of ash pans made. The condition of front ends and ash pans must not only be reported on special form for that purpose, if repairs are necessary, but the condition as found must be carefully noted in book or blank form and signed for by the inspector or inspectors actually making the inspection.

"If repairs are necessary, the front end and ash pans must be re-inspected upon completion of repairs and proper notations as to condition made in the book or blank provided for that purpose and signed by the inspector actually making inspection.

"Books or blanks when filled should be forwarded to the master mechanic, who will send them to the superintendent of motive power, upon whose division the locomotive has been in service."

The approximate danger line from sparks is 150 feet distance from the center of the track. In confirming this statement the testimony of those who have had occasion to observe the progress of fires originating from locomotives is to the effect that while objects located at a greater distance sometimes burn, the firing of such objects is not the immediate result of sparks from a locomotive, but that of a flying brand from the original spark fire within the above distance. These conditions, however, would not prevail with a defective spark arrester. So small is the heat carrying power of a spark from a locomotive in good condition that there is doubt as to whether or not they cause a fire. Well known laws applied to falling bodies show that sparks sufficiently large to carry fire must under ordinary conditions of discharge and of wind velocity, strike the ground within a comparatively short distance from the track.

There is, therefore, nothing to bear up the locomotive spark but the initial velocity with which it is projected. From considerations, it should be evident that conclusions based on observation in connection with fixed fires are not applicable to the conditions affecting sparks in locomotive service.

We believe with a uniformity in respect to careful maintenance of the corrective influences that have been devised up to date, that much can be done in preventing the large fire waste caused by flying sparks. This, however, must receive careful individual co-operation on the part of all employes and the motive power departments and our hope is that we may be able in the future to acknowledge the result of the work of some inventive mind that will bring about the entire elimination of fires caused by sparks thrown from the smoke stack of locomotives.

Brazing Solder Preparation.

There are two rather common methods of preparing brazing "spelter" or solder, one being by pouring the molten alloy into a tank of water and the other by breaking up heated bars in a mortar. In either case the alloy is carefully made in plumbago crucibles, there being no difference in this part of the work, while the metal is very carefully skimmed before pouring. In the wet process the molten metal is poured through a sieve of suitable mesh into a tank some distance below, and when sufficient has been poured, the water is drawn off and the metal dried and graded for size through sieves. In the dry process the metal is poured into bars which are heated to the granulating temperature and then smashed up with a heavy iron pestle, reheating being done as necessary. Grading is the same as in the first process.

Drilling Job.

Sometimes a job may arise where tapped screw holes require that the lower part of the holes should be larger so that there will be no thread in that part of the hole. It may be impossible to approach that part of the holes from the bottom. All that is necessary is to drill the required depth the first half of the hole, then take the same drill and grind off one of the cutting sides, throwing the point of the drill out of center. This will increase the lower part of the hole in a ratio to the eccentricity of the drill.

Bronzing Cast Iron.

Cleanse the metal and rub it smooth. Apply evenly a coat of sweet or olive oil and heat the iron, being careful that the temperature does not rise high enough to burn the oil. Just as the oil is about to decompose, the cast iron will absorb oxygen, and this forms upon the surface a brown oxide skin which holds securely and is so hard that it will admit of a high polish, thus giving it the appearance of bronze.

Blueing Iron or Steel.

Dissolve 4½ ozs. of hyposulphite of soda in a quart of water and 1⅛ oz. of acetate of lead in another quart of water. Then mix the two solutions and heat until boiling. Then immerse the pieces of iron or steel to be colored. The metal will take a rich blue color, and is more enduring than the color produced by tempering.

Lacteal Lubrication.

In cutting threads in copper, or otherwise cutting copper in machine tools, there is frequently considerable difficulty in producing a smooth surface. Lubricating will generally bring about the desired result, but the use of milk as a lubricant never fails to produce the finest finish on copper.

Nickel Plating.

Light nickel plating can be accomplished by heating a bath of pure granulated tin, argol and water to boiling and adding a small quantity of red hot nickel oxide. A brass or copper article immersed in this solution will be instantly covered with pure nickel.

United States Railroad Administration Standard Type of Single Sheathed Box Car Allotted to the Carolina, Clinchfield and Ohio Railroad

It is a matter of satisfaction to learn from many railroad men that the new cars built by the leading manufacturers under the supervision of the United States Railroad Administration are meeting the severe service with a degree of stability that marks an advance in car construction. As is well known the designs and specifications were established at the suggestions of the leading experts in America, and apart from the advantages derived from a standardization in the matter of details, there is a degree of thoroughness in the construction that shows how carefully the work has been done, even under the pressure naturally arising from congested traffic and a universal clamor for increased equipment.

The draft gear is of the friction type, having a minimum capacity of 150,000 lbs., and a maximum travel of 2¾ ins., designed so as to fit exactly into the space provided. The clearance between the coupler horn and striking plate is 3 ins. The following types may be used: Cardwell, Murray, Sessions, type "K" Westinghouse, and Miner. The draw bar yoke is of the vertical plane type; the coupler of cast steel, in accordance with M. C. B. contour, having 6 ins. by 8 ins. shank, 21¼ ins. long, and slotted tail of proper length to suit draft gear. The cars are equipped with Westinghouse KC-10-12 type of air brake, of either Westinghouse or New York Air Brake Company's manufacture. Brakes are and center sills. The side linings are also of fir or yellow pine, 5 ins. face width, secured to ports and braces. The end linings are also of fir or yellow pine, 1½ ins. thick, 5 ins. width, all lining being tongued and grooved. The roof is of galvanized steel, No. 22 gauge outside metal roof, laid over yellow pine roof boards, 1 3/16 ins. thick by 3¼ ins. or 5¼ ins. width.

The steel ends embrace an approved feature adding to the durability of the car by three horizontal corrugated sheets, top sheet 3/16 in. thick; intermediate and bottom sheets ¼ in. thick, with corrugations 2¼ ins. deep. Some of the cars are constructed with two vertical corrugated sheets, both being ¼ in. thick with

SINGLE SHEATHED BOX CAR FOR THE CAROLINA, CLINCHFIELD & OHIO RAILROAD.
Bettendorf Company, Bettendorf, Iowa, Builders.

Among other manufacturers, the Bettendorf Company are building 50-ton single-sheath box cars at their plant at Bettendorf, Iowa. Our illustration shows this type of car allocated to the Carolina, Clinchfield & Ohio railroad. The materials and construction throughout are of the most substantial kind. The center sill construction is designed to meet M. C. B. requirements, having an area of not less than 24 square inches in cross section and a ratio of stress to end load not exceeding .06. All bolts for securing steel against steel a[illegible]ed with cotters, lock washers [illegible] nuts, in addition to common r[illegible] bolts for securing wood again[illegible] steel [illegible]e riveted over the nuts.

applied to all wheels and also arranged to be operated from one end of the car by hand. The braking power is about 60 per cent of the light weight of the car based on 50 lb. cylinder pressure. Piston travel between 5 and 7 ins. Hand brake power approximately the same as the air brake power. All piping of black steel, standard weight, and fittings of malleable iron.

The coupler operating device is of the top operating type without the use of clevises, links and pins; that is, they are direct connected to the locking block. The flooring of the car is of fir or long yellow pine, square edge, 2¼ ins. thick, tongued and grooved, 5¼ ins. to 7¼ ins. face width, firmly secured to the side corrugations 2¼ ins. deep.

The following are the general dimensions of this type of standard car:

Length inside, 40 ft., 6 ins.; Width inside, 8 ft., 6 ins.; Height inside, 9 ft.; Length over striking plate, 42 ft., 1½ ins.; Width over eaves, 9 ft., 3¼ ins.; Width over all, 10 ft., 2¼ ins.; Height from rail to top of car at eaves, 12 ft., 9 ins.; Height from rail to top of brake mast, 14 ft., 1¾ ins. Height from rail to top of running board, 13 ft., 6⅞ ins.; Distance center to center of trucks, 31 ft., 1½ ins.; Height from rail to center of coupler, 2 ft., 10½ ins.; Height from rail to bottom of center sill, 2 ft., 4½ ins.

Several thousands of these cars are already in operation.

The Baker Locomotive Valve Gear

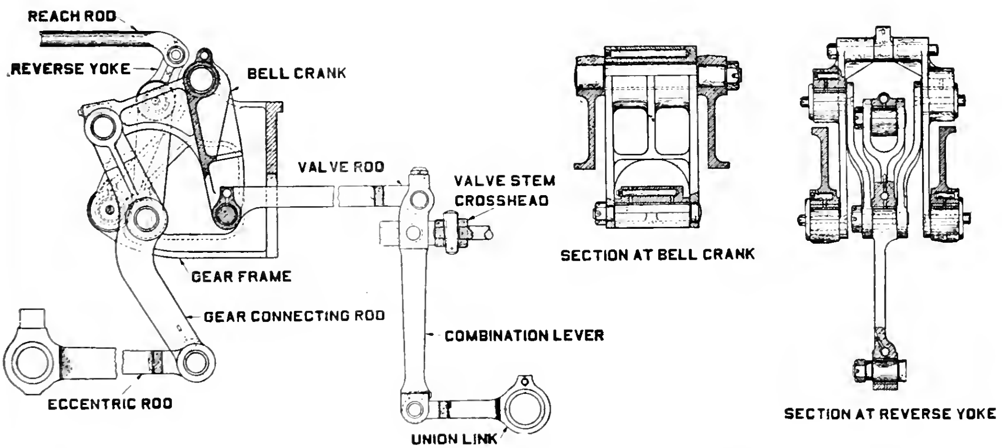
Treatment of Breakdowns in Emergencies

The universal recognition of the marked improvement in what may be called the outside application of locomotive valve gears as compared with the older method of inside applied valve gearing, is so generally accepted that there is little need of discussing the general advantages to be derived from the outside gearings. It is well, however, that the methods of meeting emergencies should be occasionally referred to, as improvements or means and material never fully meet disasters which are inevitable under any condition. This, to a limited extent, arises from the fact that there is a necessity for making the working parts of the valve gear light, as engines themselves came to be built heavier with each successive installment. When heavy valve gear on large engines was worked at high speeds it soon became apparent that a good deal of wear resulted and derangement frequently took place, and many breakages and other failures could be traced to this cause.

In order to avoid what could be avoided, valve gear was, wherever possible, reduced in weight, and alloy steel, having enduring qualities, was substituted for the heavier parts. In order to carry out this substitution properly the dynamic augment, as it is called, was studied by those having to do with valve gear. This scientific term, more or less formidable in appearance, is not so terrifying when properly understood. The "augment," as far as it applies to valve gear, is not essentially different from the same term applied to counterbalancing. It may in general be defined as, the tendency of reciprocating parts, when once they have been set in motion, to keep on moving, and this necessarily requires a force to stop them and reverse their motion.

It is, therefore, easy to see that the lighter the static weight of any part of the gear can be made the less the dynamic augment will be for a given speed, and the less wear and the less possibility of derangement that will exist. In that particular it may be briefly stated that the Baker valve gear possesses excellent features.

It is needless to point out the mechanical features of the Baker gear; suffice it to say that the eccentric crank is set at 90 deg. to the center line of the eccentric rod. It always follows the main crank pin in forward motion, and has a constant lead. That it is a formidable rival of other valve gears is conceded by those interested in such matters.



ESSENTIAL PARTS OF THE BAKER VALVE GEAR FOR LOCOMOTIVES.

Our illustration shows the essential parts of the Baker valve gear for locomotives, and in case of breakage occurring, the following instructions, which are arranged in the question and answer form are submitted, and have already met the approval of a mechanical committee on one of the leading railroads:

1—Q. Should you break eccentric crank, eccentric rod, gear connection rod, (upper or lower part), radius bars or horizontal arm of bell crank, what would you do?

A. Remove eccentric rod and apply U bolt in holes in gear frame, securing vertical arm of bell crank which supports combination lever and provides lap and lead travel in all points of cut off. Proceed with such portion of train as conditions warrant.

2—Q. Should you break crosshead arm or union link, what would you do?

A. Should a rod be provided to secure lower end of combination lever to guide yoke, would remove broken parts and proceed with full train, working engine at long cut off. Otherwise would remove broken parts, combination lever and valve rod, cover ports and proceed on one side.

3—Q. should you break combination lever, lower arm of bell crank or valve rod, what would you do?

A. Remove broken parts and valve rod, block valve over ports by means of set screw provided for that purpose and proceed on one side.

4—Q. Should you break reverse arms or reach rods, what would you do?

A. Remove broken parts, block disabled side in desired position and proceed with train, it being understood that engine should not be reversed without first changing blocking on disabled side.

5—Q. If tumbling shaft or tumbling shaft box break, what would you do?

A. Remove broken parts block reverse yoke in desired position and proceed with train.

6—Q. Should reverse yoke break above radius bar suspension, what would you do?

A. Remove short reach rod and block yoke in desired position, changing blocking if necessary to reverse motion and proceed with train.

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The Industrial Board of the Chamber of Commerce.

A government report is "told with such remarkable fullness that nobody reads it on account of its dullness," but out of the maelstrom of muddled matter there are occasional waves of thought which, like flashes of light out of a clouded sky, show that beyond the darkness there is a promise that the shadows may flee away. Among the bewildering bundles that come to us from Washington, there is an announcement that the Council of National Defence is creating what will be known as "the Industrial Board of the Department of Commerce."

This Board will be charged, under the approval already given by the President to the Secretary of Commerce, with the stabilization of prices for basic materials in such a fashion as to create a firm foundation on which the consumer can base his future purchases and the producer can form necessary production cost estimates. Its program will be supported by the Council of National Defence. Through proper investigation and stabilization it is expected that the foundation can be laid for the resumption of American business and for the furnishing of employment to returning soldiers and sailors—this through Government purchases, the publication of fair price lists, and cooperation of the producer. To obtain this cooperation of the producer, it is planned that the board shall call the various leaders of industry into consultation. The first of these conferences will be with representatives of industries producing basic materials, such as iron, steel, lumber textiles, cement, copper, brick, and other construction materials.

The immediate need for carrying out Secretary Redfield's program is evident, for there exists at the present time an abnormal situation in the industrial world—a stagnation of business and industrial activity. Mills and factories are idle, or are producing but a small part of what they are capable of doing, and building operations are at a standstill. A large amount of unemployment exists, and this unemployment is increasing at such a rate as to challenge the best thought that can be given to the situation. This present condition has come about through a series of unusual happenings, due to the war. The industries and labor of the country were diverted into new and unnatural channels, in order to mobilize all efforts possible. The capacities of many factories were expanded, new ones built, abandoned plants remodeled and put into production, and industry was managed and operated in accordance with war necessities—all largely under Government control.

It is felt that the proper basis of selling prices for the present will be found to be upon a scale considerably higher than those of the pre-war days. However, the level should be established on the lowest plane possible, having due regard to industry, labor and Government, the announcement of such a plane of prices will immediately create confidence in the buying public. It is also believed that the reductions from the high prices to the proper level, so that consumers may be justified in buying, should be made at once by one reduction. Industry and labor have a mutual interest in remedying present conditions, but industry should take the first step by the reduction of prices and commodities and should require of labor as little aid as possible.

Colloidal Fuel.

Recent experiments in fuel saving have produced a great deal, but it is doubtful if anything equals the saving of coal and oil as the overcoming of the hitherto insuperable difficulty of making a composite of the two elements. The persistent settling and a sedimentation of the heavy coal and tar particles destroyed the value of all mechanical mixtures. Until now the best that in a practical way chemical science could do, was with the aid of tannin to suspend in oil less than one per cent of Atcheson graphite 75 mm. in average size.

Today it is possible to suspend for months in oil 30 per cent to 40 per cent of coal, pulverized so that about 95 per cent passes through a 200 mesh screen, assisting the suspension with a special fixateur. The average size of the coal particles is many times that of the graphite particles in lubricating compounds. It is now possible to combine in a stable liquid fuel about 45 per cent oil, 20 per cent tar and 35 per cent pulverized coal, thereby replacing over one-half of the oil, securing equal or greater heat values per barrel and saving considerable cost. Asphaltic and free carbon particles in Pressure-Still Oil may also be stabilized, thereby rendering available for metallurgical uses a low sulphur oil.

Pulverized coal burned alone cannot in many cases replace oil. Especially is this true on shipboard. Radical changes in oil-burning installations become necessary, its storage requires too much space and thus limits the cruising radius of war vessels.

The new Colloidal fuel has received most thorough investigation on land and sea. Trials in Long Island Sound have been made before representatives of our own and several Allied official bodies and corporations, some of which have followed the tests with permanent representatives. For land use a fuel plant has been installed at one of the large refineries and its results confirm all claims.

Industrially the fuel will have an abiding value in all countries. For naval use it will be valuable where liquid fuel is scarce as in Great Britain, France and Italy. In the latter country the lean lignites of Sicily and those of the villa-dotted Arno Valley are given value as with the magic of a spell. For France what she has left of coal is transmuted into gold. The fuel-life of England is lengthened. All her Empire and all the earth where carbon seams its bosom is enriched for men will have it longer to use and to enjoy. In brief it will enable the American, British, French and Italian navies to use less oil, yet to maintain their cruising and emergency speeds, or to increase the patrol-mileage practicable with the present consumption of oil.

There are achieved several other objects—one to permit the conservation of American oil and coal without sacrifice, hardship or loss of industrial efficiency; another to enable greater use of the high sulphur oils or coals by averaging down the sulphur content in the mixed fuels burned; a third object, through lessening refinable oil consumption in metallurgical, navy and railway use, to leave more to refine for valuable products; a fourth to enable the cheaper and poorer coals and those high in ash content to be burned with the best efficiency, now that the world's high grade coals are being gradually exhausted.

Regarding the saving of cost involved in the use of Colloidal fuel it has been demonstrated that with coal at $4.00 per

ton and oil at $4.00 per 50 gallon barrel, the saving is $2.00 per ton. This is an average peace condition in New York City. If coal is $5.00 per ton and oil $7.00 per barrel, the saving is close to $6.00 per ton. These savings are quite apart from the conservation of oil and reduction of transport.

Exchanging Liberty Bonds.

Among other flashes of truth that come from the multitude of Commissions that live and move and have their comfortable being in Washington, the Federal Trade Commission, so called, we are advised that there is an army of "get-rich-quick" swindlers abroad in the land whose object it is to exchange stocks of questionable value for Liberty Bonds. The interest on the government bonds is as secure as the rock of Gibraltar. The fake promoter's stock is like Wordsworth's cuckoo—"an invisible thing, a hope, a mystery." About twenty million American patriots bought Liberty bonds. The great bulk of these people can afford to keep them. Should circumstances compel some of them to dispose of their bonds, they should deal with their local bankers. Wild-cat promotion is flagrant. Like the pestilence that walketh at noon-day, it should be avoided.

The average railroad man is not a sucker. He is practical and hard-headed. They may not all be from Missouri, but they are all human, and to err is human. If any of them have a call from one of the pleasant representatives of the sharper outfit, send a postal card to the Federal Trade Commission at Washington and tell them the name and address of the "salesman," or send it to us, and we will notify the proper authorities. A word to the wise is enough.

The Coming Conventions at Atlantic City, N. J.

The Railway Supply Manufacturers' Association is earnestly at work in conjunction with the Master Car Builders' Association, and American Railway Master Mechanics' Association making extensive arrangements for exhibits of railway supplies, and the conventions to be held at Atlantic City, N. J., beginning on Wednesday, June 18, and closing on June 25, the first three days being devoted to the convention of the Master Car Builders' Association, and the last three days to that of the American Railway Master Mechanics' Association.

In regard to the work of the Railway Supply Manufacturers' Association, as this is the first exhibition that has been held for three years, it may be relied upon that no pains will be spared to make the display a memorable one. The Railroad Associations have expressed their earnest desire that the Supply men should make a full exhibit, and the United States Administration gives its unqualified approval of the proposition. Invitations are being extended in the name of the three associations to all foreign trades bodies in this country, and, through the Embassies at Washington, to all foreign governments, except the Central Powers, inviting them to send delegates or representatives to attend the conventions and examine the exhibits. The opportunity presented by an exhibition at this time for both the domestic and foreign demand is very exceptional.

Meanwhile official circulars are being distributed furnishing complete details of the arrangements that have been already completed. These include particulars in regard to track exhibits, which by arrangements with the Philadelphia & Reading railway will be amply accommodated within 200 yards from the main exhibition hall. The decoration features will show a marked improvement. Additional exhibit space has been secured. The entire interiors of the buildings on Young's Million Dollar Pier, where the main exhibits will be displayed, and the conventions held, will look as if they were completely renovated, as indeed they will be as far as the decoration of walls and ceilings and flooring is concerned, to which will be added all the full-blossomed beauty of floral decorations.

A very gratifying expression of approval from many of the leading manufacturers of railway supplies already has been received, and applications for space are being received with a degree of promptitude that bids fair to surpass any previous exhibition of the Railway Supply Manufacturers' Association. Assignments are being made at the office of the Association, 1811 Oliver Building, Pittsburgh, Pa.

Congress Should Act.

Experience demonstrates that railway buying always stimulates and sustains employment and general prosperity. Every agency of the Government is urging employment be provided for returning soldiers.

BOOK REVIEWS

Remedial Railroad Legislation. Edited by Robert S. Benkherd, assistant to the chairman of the Association of Railway Executives.

The testimony before the Senate Committee on Interstate Commerce and statements bearing on the return of the railroads of the United States to private management and operation, and on remedial legislation to accompany such return, as suggested by the Association of Railway Executives, is a timely addition to the railroad literature of our time, embracing as it does the plan of association of railway executives, and the complete testimony taken before the committee of the United States Senate. A perusal of the two volumes on which the publication appears is illuminating, both in regard to the important evidence furnished by some of the leading railroad men of America, as well as the genuine spirit of fairness with which the committee of Senators have conducted the investigation. It is fundamentally essential that the difficulties which have been confronted should be reduced, and if possible, abolished altogether. Railroad men generally, and members of both houses of Congress particularly, should peruse these volumes.

American Railway Accounting, by Prof. Henry G. Adams. Published by Henry Holt & Company, New York. Price three dollars.

This book cannot fail to be immediately accepted as the most reliable authority on the condensed system of railroad accounting. It explains clearly the standard system of accounting rules. It will be of intestimable value to the young accountant, and to others who are no longer young. Prof. Adams has brought to his task a wide experience, and has long been a recognized authority both in railroad and governmental accounting. He was for several years in charge of the financial records of the Interstate Commerce Commission, and is now professor of political economy and finance in the University of Michigan.

Manual of Inspection and Information for Weights and Measures Officials, by F. S. Holbrook, Inspector of Weights and Measures, Bureau of Standards.

Among the miscellaneous publications issued from the government printing office the work before us on weights and measures is of value to those who may be in close touch with the construction and maintenance of these instruments. To the railroad man the section and platform scales furnishes the details of the approved regulations in regard to their structure and maintenance. The weights and measures of foreign countries and their equivalents are also appended, as well as a model state law which has been evolved from conferences on the subject.

The Traffic Field. Published by the La-Salle Extension University of Chicago. Fully Illustrated.

This is the first book of its kind published and should help greatly in clarifying the maze of ignorance that exists in shipping conditions. As is well known, goods are improperly packed and frequently sent by the wrong routes and the proper inspection of charges neglected. The loss in these ways is more than would be believed. The essential facts about this class of work are to be found in this book, and is the combined work of the most accomplished experts in the various sections of the work.

Air Brake Department

Variable Load Brake—Equalization of the Empty and Load Brake on Passenger Cars

The Variable Load Brake is sometimes known as the Empty and Load *Passenger* Brake. Its purpose is to develop the same braking effectiveness regardless of the number of passengers carried. In other words, the length of stop will be practically the same under all conditions of load; i. e., with any number of passengers, this equipment will bring a given train to rest from a given speed in the same distance.

Since this arrangement permits a car to be braked within the closest safe limit of wheel sliding under all conditions of load, trains may be operated with minimum possible headway and signal spacing, and stopped accurately at station platforms as rapidly as possible. By this means, the maximum carrying capacity of the track, as far as brakes are concerned, is developed under all conditions of load. In ordinary traction service, it is seldom necessary to approach within a wide margin of this capacity. But, in large cities, on the other hand, to secure adequate returns on lines costing hundreds of thousands of dollars per mile, to relieve traffic congestion and to meet the public demands for rapid transit and frequency of service, the maximum carrying capacity of the track must sometimes be realized. This is the field of the Variable Load Brake.

The feature of preventing an appreciable variation in stopping distance is obtained with the Variable Load Brake by increasing, as the car load increases, the brake shoe pressure secured per pound brake pipe reduction; e. g., if, on an empty car 400-pounds shoe pressure is produced per pound brake pipe reduction, the shoe pressure developed on the same car when loaded to *double* its empty weight, will be *twice* as much as when empty; viz., 800-pounds. The change in shoe pressure is realized by varying the brake cylinder pressure per pound brake pipe reduction, which, in turn, is produced by varying the size of the auxiliary reservoir volume. This adjustment of auxiliary reservoir volume is secured automatically by an actuating mechanism regulated by the downward settling of the car body on its springs as the passenger weight increases. The variable load mechanism is free to adjust itself to the total car weight only when the doors are open, as during the interchange of passengers; but with the doors closed, as is the case with the car in motion, the mechanism is locked, so that any change in position of the car body, due to the car's motion, will not produce a false setting of the variable load or "weighing" mechanism.

The essential parts of the variable load portion of a Variable Load Brake Equipment are: a four-compartment reservoir (1), containing different size compartments, which are added to the main auxiliary reservoir volume in various combinations, as the passenger load increases; a regulator valve (2), permitting the compartment combination to be regulated with the car at rest and automatically holding that adjustment with the car in motion; limiting valves (3), limiting the maximum obtainable brake cylinder pressure during service and emergency brake applications, respectively, for different car-loads—this is necessary, because with this equipment the braking forces are just within the safe limit of wheel sliding for the normal brake cylinder pressures employed and hence, if a brake cylinder pressure *higher than normal* is not prevented from developing, as would otherwise be the case from an *over-reduction in brake pipe pressure*, with a sufficiently high nominal brake pipe pressure, wheel sliding would result; and a plank cylinder and actuating mechanism (4), with a piston which, in its outermost position, barely touches the regulating mechanism when the car is empty, and with it loaded, moves the regulating mechanism forward just a sufficient distance to vary the auxiliary reservoir volume in proportion to the passenger load.

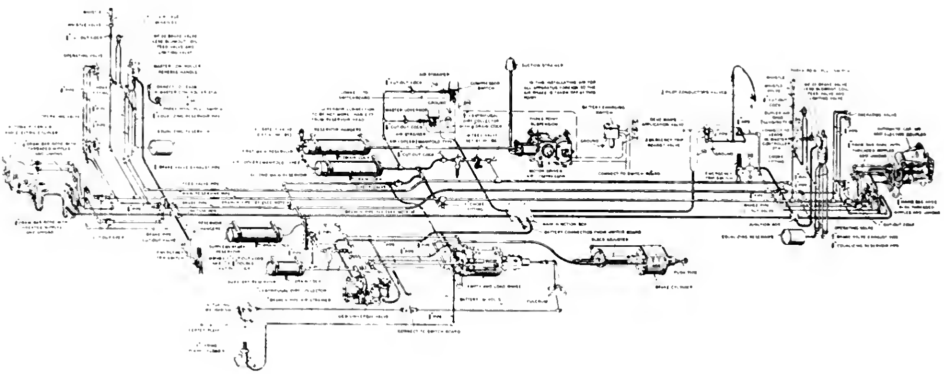


FIG. 1.

The brake valves, triple valve devices and kindred mechanisms employed will not be considered in this discussion, because particular types are not essential to the variable load mechanism, although it is obvious that it would be inconsistent to obtain the highly developed features secured through the Variable Load Brake without using the highest developed types of brake valves and triple valve devices in service.

Figure 1 shows a diagrammatic piping arrangement of an entire Variable Load Equipment; and Figure 2 that of the variable load portion proper.

The operation of the variable load portion of the equipment is as follows: (See Figure 2). Consider the operator to be

charging the equipment of an empty train, with the doors closed, while preparing to leave the barn. The closed doors keep the circuit of magnet valve (5) open. Hence, the magnet valve (5), being de-energized, cannot exert a magnetic force to hold its plunger (76) down against the resistance of spring (101), whereupon the latter forces the upper magnet valve (77) to and its lower magnet valve (8) from its respective seat. Thus, a communication is established between the cylinder cap chamber (11) and the regulator valve piston chamber (6) through passage (7) past lower magnet valve (8) through passages (9) and (10), so that the main reservoir air entering chamber (6) atmospheric pressure on account of being maintained at that pressure when the brakes are not applied) the resultant pressure forces double piston (24) with its slide valve (28) inward, until the slide valve pin (29) engages with projection (30) of the notched rod (31). At the same time, supplementary reservoir air also flows from passage (18) through passage (34) into chamber (35), holding regulating mechanism slide valve (28) to its seat (36). Thence the supplementary reservoir air passes through port (116) and passage (31) into chamber B; port (117) and passage (45) into chamber C; passages (118) and (48) into chamber D; passage (43) into chamber E. limiting valve (3). The service limiting valve operates substantially as a feed valve; its purpose, as previously explained is to prevent the development of an excessive brake cylinder pressure, through an overreduction in brake pipe pressure, which would cause wheel sliding. At a predetermined pressure, the air in passage (63 overcomes the atmospheric pressure and spring pressure in the supply valve spring chamber (65), forcing the supply valve (64) from its seat (66) and permitting the admission of air from passage (65) through passages (67) and (68), and pipe (69) to the brake cylinder (74). With the car empty, the operator can develop any cylinder pressure desired up to 35-

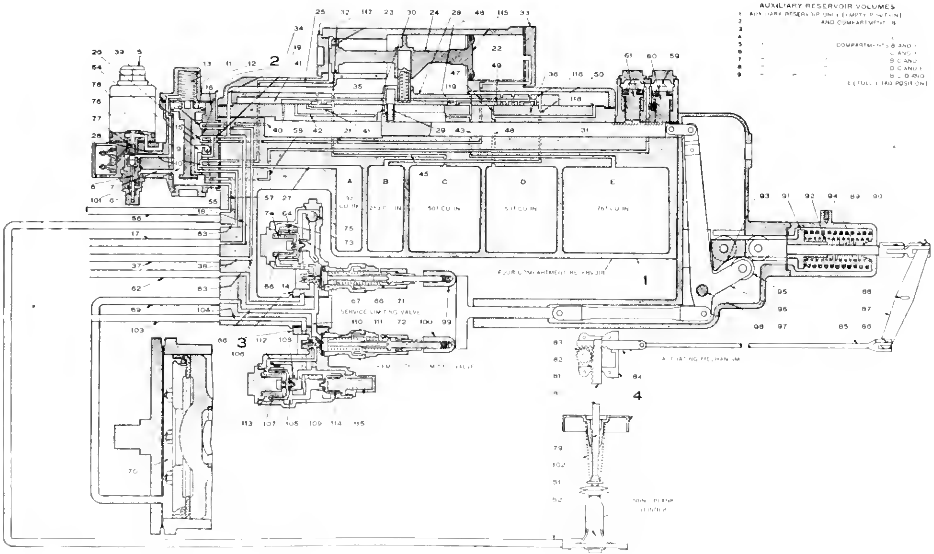


FIG. 2.

through pipe (56) and passage (57) maintains an equal pressure on both faces of the regulator valve piston (12). Under these conditions, the regulator valve piston spring (13), having the balance of force, holds the regulator valve piston (12) and its slide valve (15) in their innermost position. The resultant registration of ports between regulator valve slide valve (15) and its seat (16) permits supplementary reservoir air to flow through pipe (17), passages (18) and (19), port (20), passage (21) to chamber (22). Now with the air in chamber (22) exerting full supplementary reservoir pressure on the outer face of piston head (115), and air exerting atmospheric pressure on the outer face of the smaller head (23) of the double piston (24) (by virtue of the connection through passage (25), port (26) and passage (27) to leakage chamber (A) the air in which chamber is at

The position of regulating valve piston which permits the charging of these chambers also connects the spring plank cylinder piston (51) through pipe (52), passage (53), slide valve port (54) and exhaust port (55) to the atmosphere. At the same time, main reservoir air through passage (58), forces the latch pistons (60) and (61) downward, holding notch rod (31) rigid in the position determined by the plank cylinder and actuating mechanism (4).

If, after leaving the barn, the operator makes a service brake pipe reduction, the air in chambers B, C, D and E, on account of being connected to the supplementary reservoir, remain undisturbed, and the regulator slide valve (12) continues to hold its former position. As a result of the reduction, however, the triple valve device admits air to the brake cylinder pipe (62), passage (63) to the service

pounds, (in load, 50-pounds) which, in this position, is realized with a 20-pound reduction in brake pipe pressure. The limiting valve prevents any further rise in brake cylinder pressure, as follows: The position defined by the limiting valve pusher link (98), regulating nut (99) in empty position, so load the regulating spring (71) that with 35-pounds pressure per square inch in brake cylinder passage (67) its force is overcome and regulator valve (14) permitted to assume its seat. Thereupon, the communication between supply valve spring chamber (65) and brake cylinder passage (67) is cut off, so that air in passage (63) immediately builds up an equal pressure through choke (73), whereupon the supply valve spring (74) forces the supply valve piston (64) to its seat (66), preventing further admission of air to the brake cylinder.

When the operator, in desiring to re-

lease the brakes, restores the brake pipe pressure, the triple valve device piston is forced to release position. Then the air in chambers B, C, D and E, being part of the supplementary reservoir air, in empty position, helps to charge the auxiliary reservoir. As is customary, with quick recharge triple valves, the supplementary and auxiliary reservoir pressures equalize and then full pressure in both is reinstated by the air received from the brake pipe. At the same time, brake cylinder air is released by flowing from the brake cylinder (70) through pipe (69), passage (68), past check valve (75) into passage (63) and pipe (62), through the triple valve exhaust port to the atmosphere. It should be noted that ball check valve (75) is used to permit the release of brake cylinder air without the interference of the limiting valve.

If the train is stopped at a station where passengers are interchanged, the change in passenger load will alter the adjustment of the mechanism as follows: The opening of the doors closes the regulating magnet valve circuit. The resultant energization of magnet (5) causes the magnet valve stem (76) to move downward, seating the lower magnet valve (8), thereby cutting off communication between regulating valve chamber (6) and cylinder cap chamber (11), and simultaneously unseating upper magnet valve (77), thus exhausting the air in cylinder cap chamber (11), through passage (9), past the upper magnet valve (77) into the exhaust cavity (78). With only atmospheric pressure now in cylinder cap chamber (11), the main reservoir air, contained in the regulator valve piston chamber (6), overcoming the resistance of regulator valve piston spring (13), forces the regulator valve piston (12) to its outermost position. In this position of the regulator valve slide valve (15), chamber (22) and its passage (21) are connected to the atmosphere through port (54) and exhaust cavity (55), while the outer face of the smaller head (23) of the piston (24) is disconnected from the exhaust chamber A and its passage (27), and connected to the supplementary reservoir passage (19). Hence, with atmospheric pressure on the outer face of the larger piston head, and supplementary pressure on the outer face of the smaller piston head, a resultant force is developed which forces the double headed piston (24) with its slide valve (28) to its outermost position against piston cover (33). The piston (24) and slide valve (28) are moved in this manner, in order to permit the notch rod (31) to be adjusted without interference from the friction of the slide valve (28), as will be described later. In the position of the regulator valve piston slide valve (15) in which this latter functioning occurs, the exhaust chamber A, when cut off from the small piston head (23), as previously mentioned, is connected through passage (27), port (54) and exhaust cavity (55) to the atmosphere. This communication is made to insure that only atmospheric pressure must be overcome when returning the double headed piston (24) to its original position, with the doors closed, as will be explained later. The slide valve also disconnects the auxiliary reservoir passage (38) from the passage (40) in order that during the rearrangement of the compartment combination there will be no tendency of the air to enter the auxiliary reservoir through the passage (38) which cannot be controlled by the triple valve device, graduating valve.

In addition, the regulating valve slide valve (15) disconnects the spring plank cylinder chamber (51), its pipe (52) and passage (53) from the atmospheric cavity (55) and connects it to the main reservoir air in regulator slide valve chamber (6). The main reservoir air, thus introduced into the spring plank cylinder chamber (51), forces the piston with its intermediate strut (79) upward. Now, under these conditions, when the car is empty, the upper end (80) of the intermediate strut (79) just touches the face (81) of the vertical rack (82), resulting in an adjustment of the regulating mechanism, and arrangement of compartments, as described in the preceding portion of this discussion. If, however, the car is loaded to *full capacity*, the added weight will cause the car body to depress its springs and approach more nearly to the trucks. Hence, when the intermediate strut (79), is forced to its outermost position under load conditions, the face (80) not only touches the face (81), but the intermediate strut (79) forces the vertical rack (82) upward through a certain distance. The opinion (83) thereupon revolves counter-clockwise, drawing the horizontal rack (84), with its pull rod (85) inward. Thereupon, pull rod (85) moves end (86) of connecting lever (87) about the fulcrum (88), in a clockwise direction, causing end (89) to draw crosshead (90) and return spring collar (91) outward against the resistance of the return springs (92). Since cam (93) is rigidly connected to the cam operating rod (94), it also moves outward while roller (95) rolls upon the cam surface, causing the roller to move downward. Thus, lever (96) to which roller (95) is attached, revolves about fulcrum pin (97), so that limiting valve pusher link (98) moves inward and the notch rod (31) outward. Thereupon, the limiting valve pusher link (98) acting against the regulating nuts (99) and (100) compresses the limiting valve springs (71) and (72), thereby raising the maximum limit for the pressure admitted to the brake cylinders. In this manner, the limit of the braking force required to compensate for the increased load is increased, so that the stopping distance in load position will be substantially the same as in empty position. The other action caused by lever (96); i. e., the outward movement of notch rod (31), is accomplished with little resistance on account of the regulating mechanism slide valve (28) being moved to its outermost position by the actuation of the double head piston (24) as previously explained. The position thus assumed by the notched rod results in the proper combination of load condition when the double head piston is retained, as explained in the next paragraph.

The closing of the doors, following the egress and ingress of passengers, prior to the car leaving the station, breaks the regulator valve magnet circuit and thereby deenergizes the magnet valve (5), whereupon the magnet valve spring (101) forces the magnet valve stem (76) upward, disconnecting the outer face of the regulator valve piston (12) through its chamber (11) and passage (9) from the atmosphere and connecting them to the main reservoir air contained in slide valve chamber (6) by way of passage (7) and lower magnet valve passage (8). The equalization of pressures on both faces of the regulator valve piston (12) resulting, enables the spring (13) to force the piston (12) to its innermost position, disconnecting the outer face of the larger head (115) of the double headed piston (24), its chamber (22) and passage (21) from the atmospheric port (55) and reconnecting it to the supplementary passage (19), through the cavity (20). At the same time, chamber A is disconnected from the exhaust passage (55) and reconnected to the outer face of the smaller head of the double headed piston (24). Inasmuch as the pressure in the exhaust chamber A was reduced to that of the atmospheric pressure by the operation of the regulator slide valve (15), only atmospheric pressure is exerted on the outer face of piston head (23), so that when supplementary reservoir air is admitted to the chamber (22), as just explained, the double headed piston (24) is forced inward until its slide valve pin (29) engages with the projection (30) of the notched rod (31). With a loaded car, this inward movement is only a comparatively small portion of its maximum travel on account of the outward position of the notch rod, determined by the adjustment of the spring plank cylinder and actuating mechanism (4). The slide valve (28) halts as soon as it strikes the projection (30) because the notch rod (31) is held locked in its position by the latch pistons (60) and (61), which, with the magnet valve deenergized, are held downward by the main reservoir air admitted from

passage (9) into passage (8) to their outer faces. Moreover, with the car doors closed, the regulator valve slide valve (15) disconnects the spring plank cylinder (51), pipe (52), passage (53) from the main reservoir air in chamber (6) and connects it through cavity (54) to the exhaust (55). Spring (102) thereupon forces the spring plank cylinder piston downward and consequently disengages the vertical rack (82).

The releasing of the vertical rack (82) through the pull rod (85), connecting lever (87), and cam operating rod (94) removes the constraining force upon the return springs (92) and enables these springs to force the cam (93) inward, ready for another operation at the next station. It is thus apparent that the mechanism is now locked in its position and any vibration of the car caused by its motion, cannot affect the adjustment obtained while it was at rest.

When emergency brake applications are made, the effect of the compartments becomes almost negligible. In fact, in emergency brake applications, with the "UC" equipment, only main reservoir air is admitted to the brake cylinder. The air in those compartments, connected to the supplementary reservoir, remains undisturbed while that in the compartments joined to the auxiliary reservoir is blown down to a predetermined pressure by the safety valve, in order to insure that the equalizing piston can be forced back into release position when the brake pipe pressure is restored. The fact that the compartments become unnecessary adjuncts during emergency brake applications should not be misconstrued so as to underestimate their vital importance for service brake applications, nor to overshadow the important role played in emergency brake applications by another portion of the variable load mechanism; viz., the emergency limiting valve.

When the triple valve device is actuated in emergency, the main reservoir air delivered to pipe (103) is carried through passage (104) into chamber (105). There, the main reservoir air, developing its pressure on the outer face of supply piston (107), forces the latter from its seat (108) and passes through passage (105) past the seat (108) into passages (109), (110), (68), pipe (69) to the brake cylinder (70). When a predetermined brake cylinder pressure is developed (60 pounds for an empty and 85-pounds for a loaded car) the pressure in passage (110) overcomes the resistance of regulating spring (72), causing the regulating valve (111) to close. Thereupon, the air in chamber (105), equalizing through choke (112) with the air in chamber (106), gives the balance of force to the spring (113), which returns supply piston (107) to its seat (108), preventing further admission of air to the brake cylinder. An excess pressure valve (114) is provided in the emergency limiting valve, so that in the almost impossible event of the regulating spring (72) breaking or of the supply piston (107) sticking, means would be afforded to permit the air in chamber (105) to lift the valve (114) from its seat and admit air to passages (110) and (68), pipe (69) into the brake cylinder (70). Spring (115) is designed to limit the pressures thus developed to that normally secured by emergency brake application on an empty car (60-pounds).

The functioning of the brakes when released, after an emergency brake application, is substantially the same as after a service brake application, as far as the empty and load portion is concerned.

While the foregoing description relates only to an empty and a full load car, there are seven other intermediate positions. In these positions, the functioning of the equipment is substantially the same as in the preceding, with the exception that the combination of compartments joined to the auxiliary reservoir vary with each particular setting. These combinations are as follows:

(1) Auxiliary Reservoir Alone (Empty Position).

(2) Auxiliary Reservoir plus B.

(3) Auxiliary Reservoir plus C.

(4) Auxiliary Reservoir plus E.

(5) Auxiliary Reservoir plus B plus E.

(6) Auxiliary Reservoir plus C plus E.

(7) Auxiliary Reservoir plus B plus C plus E.

(8) Auxiliary Reservoir plus D plus C plus E.

(9) Auxiliary Reservoir plus B plus C plus D plus E (Full Load Position).

Through these combinations, the rise in shoe pressure per pound reduction in brake pipe pressure is enabled to be increased in proportion to the car load.

The Variable Load Brake has been subjected to the intensive service of the New York City subways for the past five years, where it has been clearly demonstrated that the device is not only a practical mechanism, but that it effectively accomplishes the purpose for which it has been designed; viz., developing as far as the brakes are concerned, the maximum passenger carrying capacity and hence the maximum earning capacity of the track.

QUESTIONS AND ANSWERS

Locomotive Air Brake Inspection

(Continued from page 83, Mar., 1919.)

717. Q. How should the air piston be fitted on the taper rod?

A.—It should be fitted to have a certain amount of draw.

718. Q. About what amount?

A.—Between 3/64 ins. and 1/32 ins. for all compressors.

719. Q. What should be the distance between the air and steam pistons when drawn up solid?

A.—18 11/16 ins. for the 9½ in. pump, 21 11/64 ins. for the 11 in. pump and 22 11/16 ins. for the 8½ in. compressor.

720. Q.—What is this distance for the No. 5 and 6 compressors?

A.—21 11/32 ins. for the No. 5, and 18 23/32 ins. for the No. 6.

721. Q.—How should the air piston fit on a straight or shoulder fit?

A.—It must be fitted to draw up hard against the shoulder on the rod.

722. Q.—What is the result if the piston does not fit tight on the rod?

A.—The air piston will work loose on the rod.

723. Q.—What is the standard length between the button and shoulder of the reversing valve rods?

A.—Approximately 9⅞ ins. for the 9½ in. pump and 11 19/32 ins. for the 11 in. and 8½ in. compressors.

724. Q.—For the valve stems of the 5 and 6 New York compressors?

A.—11 17/32 ins. for the No. 5 and 9 13/32 ins. for the No. 6.

725. Q.—What is the effect of any material increase in these distances?

A.—The compressor pistons will not start to reverse as promptly as they should and a pound will develop from the pistons striking.

726. Q.—How is a compressor tested after being completely assembled?

A.—It is placed on a test rack and run at a certain rate of speed against a specified size of opening to the atmosphere when the pressure maintained indicates the condition of the compressor or checks up the accuracy of the repair work.

727. Q.—What size of orifice should be used for testing a repaired 9½ in. pump at a speed of 60 cycles or 120 single strokes per minute?

A.—3/16 in.

728. Q.—What pressure should be maintained?

A.—Approximately 60 lbs.

729. Q.—What should be the speed and size of opening for an 11 in. pump to maintain air pressure at 60 lbs. after being repaired?

A.—At 100 single strokes per minute, it should maintain about 60 lbs. pressure against a 13/64 in. opening.

730. Q.—The 8½ in. compressor?

A.—60 lbs. with 50 cycles against a 5/16 in. opening.

731. Q.—The New York 2A?

A.—60 lbs. at 120 single strokes or 60 cycles against an 11/64 in. opening.

732. Q.—The No. 6 compressor?

A. About 60 lbs. air pressure at 50 cycles against a 7/32 in. opening.

733. Q.—The No. 5 compressor?

A.—About 60 lbs. at 50 cycles against a 17/64 in. opening.

734. Q.—How can it be ascertained in a general way as to about how many cubic feet of free air a compressor is

compressing under various conditions?

A.—From the following table which shows the number of cubic feet of free air that will be expanded per minute when flowing through the different sized circular orifices to the atmosphere.

Air pressure—	50	60	70	80	90	100	120	140
1/8 in.	14.5	16.8	19.0	21.2	23.5	25.8	30.2	34.5
5/32 in.	22.5	26.0	30.0	32.5	36.0	40.0	47.0	53.0
11/64 in.	28.0	32.0	35.0	40.0	44.0	49.0	57.0	65.0
3/16 in.	32.5	37.5	43.0	47.5	52.5	58.0	68.0	78.0
13/64 in.	38.0	44.0	50.0	55.5	62.0	68.0	80.0	91.0
7/32 in.	44.0	50.0	58.0	65.0	72.0	79.0	93.0	105.0
15/64 in.	52.0	58.0	66.0	75.0	82.5	91.0	105.0	125.0
1/4 in.	58.0	67.0	76.0	85.0	94.0	103.0	121.0	138.0
17/64 in.	65.0	75.0	85.0	98.0	103.0	115.0		
9/32 in.	75.0	85.0	97.0	108.0	115.0	127.0		
5/16 in.	82.5	96.0	108.0	120.0	130.0	140.0		

cubic feet of free air per minute.

735. Q.—What determines to a large extent the number of cubic feet of free air that will flow through an orifice of a specified size in one minute's time?

A.—The length of the orifice as well as the condition of the edges.

736. Q.—Why are the figures in the above table apparently a trifle high?

A.—Because it represents the flow of air through orifices, all of which were but 1/16 in. thick, regardless of diameter.

737. Q.—How does this thickness of orifice affect a test of a repaired 9½ in. pump?

A.—It means that the compressor must be in a first class condition to maintain the air pressure at from 55 to 58 lbs. against an orifice of this kind if the orifice is full sized 3/16 in.

738. Q.—How are the orifice discs maintained in first class condition and accurate?

A.—After being in use for a sufficient time for the edges to become somewhat dulled or rounded, the discs are discarded.

739. Q.—Does a test of this kind give any indication of the exact condition of the steam cylinder or steam valve mechanism?

A.—No, a speed test is made to determine this?

740. Q.—How is this made?

A.—By operating the compressor under test with a wide open pump throttle and regulating the escape of air pressure in a manner that a fixed amount will be maintained in the reservoir into which the compressor is discharging.

(To be continued.)

Train Handling.

(Continued from page 84, March, 1919.)

745. Q.—What controls brake pipe pressure when the automatic brake valve handle is in release position?

A.—The excess pressure top of the pump governor.

746. Q.—Why?

A.—Because the brake pipe is connected directly with the main reservoir, and both are separated from the feed valve pipe.

747. Q.—And the pressure above the diaphragms of the excess pressure top is?

A. Feed valve pipe pressure.

748. Q.—Controlled by what?

A. The brake pipe feed valve.

749. Q.—Would not slight leakage past the regulating valve or slide valve of the feed valve tend to increase the pressure in this short length of feed valve pipe and prevent the operation of the governor?

A.—The warning port of the brake valve is discharging air from the feed valve pipe at this time in a volume in excess of the permissible amount of leakage past these parts of the feed valve.

750. Q.—And if the leakage was in excess of the capacity of the warning port?

A.—Brake pipe pressure would increase above the adjustment of the feed valve with the handle in running or in holding positions with the engine alone.

751. Q.—Does a reduction in brake pipe pressure necessarily result in a movement of the distributing valve?

A.—Not if the rate of reduction is too slow for service operation.

752. Q.—In what way would the valve fail to operate with too slow a reduction?

A.—Air from the pressure chamber would pass back through the feed groove, possibly past the packing ring also, at the same rate that brake pipe pressure was reducing.

753. Q.—Does an increase of brake pipe pressure after an application necessarily result in a movement of the equalizing portion to release position?

A.—Not if the proper differential necessary to move the parts is not obtained.

754. Q. In what way would the parts fail to move?

A.—The increase in pressure may be at so slow a rate as to permit packing ring leakage to recharge the pressure chamber equally with the brake pipe increase, and the movement of the equalizing portion would not be obtained.

755. Q.—What would be wrong with the brake valve in release position if the gage hands of the large gage were some distance apart?

A.—It would indicate that the gage was out of order.

756. Q. Why would this condition exist?

A. With the handle in release position both hands should show the same pressure as the pressure will have equalized.

757. Q.—Is there ever any exception to this?

A.—Only in case of two duplex or two cross compound compressors on the locomotive, in which case it is impossible to reduce main reservoir pressure below a certain figure with the handle in release position, regardless of an empty brake pipe.

758. Q.—What would be wrong if the brake was operating correctly with plenty of air pressure in the brake pipe, but one of the black hands of the gages was down at the pin?

A.—It would indicate that the hand had come loose or that the gage pipe leading to that particular tube was stopped up.

759. Q.—What is wrong with the brake valve in running position if no air pressure can be obtained in the brake pipe?

A. The brake valve cut out cock is closed, the brake pipe is open to the atmosphere or the feed valve piston is stuck shut.

760. Q.—How is the difference distinguished?

A.—By placing the brake valve in release position.

761. Q.—What would then occur if the brake pipe was open?

A.—Main reservoir pressure would fall.

762. Q.—What would result if the feed valve piston was stuck shut?

A.—The brake pipe pressure would equalize with that of the main reservoir and both would increase until the maximum governor top stopped the compressor.

763. Q.—With the brake pipe and main reservoir empty, how much air pressure will be obtained in the brake pipe and main reservoir on a passenger engine, excess pressure governor top, if the compressor is started with the brake valve handle on lap position?

A.—140 lbs. in the main reservoir and no pressure in the brake pipe.

764. Q.—What pressure will be obtained with the brake value in running or holding positions?

A.—130 main reservoir and 110 brake pipe.

765. Q.—What pressure will be obtained if the compressor is started with the reservoir cock closed?

A.—140 lbs. in the main reservoir only.

766. Q.—Will this pressure show on the air gage?

A.—No.

767. Q.—Why not?

A.—Because the air gage connections are made in the cab.

768. Q.—What pressure will be obtained if the compressor is started with an angle cock open, brake valves in running position?

A.—About 40 lbs. in the main reservoir.

769. Q.—What prevents more than about 40 lbs. being obtained?

A.—The excess pressure governor top.

770. Q.—In what way?

A.—With no air pressure above the diaphragms of the excess pressure top, the diaphragm valve will be unseated when a little over 20 lbs. pressure is obtained in the main reservoir and about 40 lbs. on the governor piston will close the steam valve against a high steam pressure under the steam valve.

771. Q.—Why can a low air pressure close the steam valve against a high air pressure?

A.—On account of the much larger area of the governor piston.

772. Q.—With the SG type of governor, or where both heads, maximum and minimum are in one body, what main reservoir pressure will be obtained if the compressors are started with the reservoir cock closed?

A.—About 40 lbs.

773. Q.—Why not full main reservoir pressure as with the SF type?

A.—Because main reservoir pressure is then under the diaphragms of the excess pressure as well as the maximum top, and the effect is identical with starting the compressor with an anglecock open, reservoir cock open, and brake valves in running position.

774. Q.—What is wrong with the SG type of governor, when the operation of all parts is correct during a brake test on the locomotive, but during the release of brakes on a train after the brake test it stops the compressor and will not permit it to start until after tapped with a hammer or wrench?

A.—It indicates that the diaphragm valve body of the excess pressure top is too neat a fit at the point it passes through the spring box.

775. Q.—Could anything else cause this?

A.—Yes, it might be caused by a piece of dirt lodging on the diaphragm valve seat.

776. Q.—What causes the diaphragm valve to stick at this particular time if it is a trifle too neat a fit?

A.—A greater difference in pressure than during the test on the locomotive alone.

777. Q.—Differences in what pressure?

A.—Main reservoir and brake pipe.

778. Q.—Can you explain how the greater difference occurs?

A.—With the brake valve handle on lap position the pressure under the diaphragms will be 140 lbs., while the brake pipe pressure may be as low as 80 lbs.; when the handle is moved to release position a sudden drop occurs in the pressure above the diaphragms, allowing practically full main reservoir pressure to unseat the diaphragms, and with sufficient force to stick them if a trifle too neatly fitted.

779. Q.—Why is not the same effect encountered during the brake test on the lone engine?

A.—Because the increase in brake pipe pressure is almost instantaneous and the rapid drop in pressure above the diaphragms does not occur.

780. Q.—How is a brake "bled" off by means of the release valve or auxiliary reservoir drain cock?

A.—By holding the valve open until the brake cylinder pressure starts to escape and then promptly closing it.

781. Q.—Why not hold it open for a longer time?

A.—It is unnecessary and causes another drain on the brake pipe.

782. Q.—From where?

A.—Through the triple valve feed groove.

783. Q.—What effect has this on other brakes in the train?

A.—It has a tendency to apply them.

(To be continued)

Car Brake Inspection.

(Continued from page 85, Mar., 1919.)

666. Q.—Could this then be considered an efficient brake?

A.—Not when the car is loaded.

667. Q.—Why not?

A.—Because there is really no provision made for an adequate brake for the car when it is loaded.

678. Q.—Has there ever been any attempt to design a brake that would provide an additional braking force for such a car when loaded?

A.—Yes, many attempts have been made but without success until quite recently.

679. Q.—Why would this not have been a comparatively simple matter to apply two complete brake equipments, one for the car when empty and the other to be cut in when the car is loaded?

A.—Because, as pointed out, the volume of air in the brake pipe and auxiliary reservoirs on the long train is already excessive, let alone doubling the auxiliary reservoir volume.

680. Q.—What kind of a brake is now used to provide an efficient retarding force for heavily loaded freight cars?

A.—An empty and load brake.

681. Q.—What is the chief feature?

A.—Two brake cylinders per car, operated with the same brake pipe and auxiliary reservoir volume now required for the standard freight car brake.

682. Q.—What is the standard freight brake now termed?

A.—A single capacity brake.

683. Q.—How is the brake operated when the car is empty?

A.—As the present single capacity, with one brake cylinder.

684. Q.—What per cent of braking ratio is used?

A.—Practically the present standard, 60 per cent based on 50 lbs. brake cylinder pressure.

685. Q.—How is the second cylinder operated when the car is loaded?

A.—By means of a change over valve and an operating lever with which the load cylinder is cut in and operated when the car is loaded.

686. Q.—Is there any more apparatus required besides the additional brake cylinder?

A.—Only several more rods and levers and a change over valve.

687. Q.—What operates the brake on the car?

A.—An improved type of K triple valve in conjunction with the change over valve.

688. Q.—What change is made in the auxiliary reservoir?

A.—It is replaced with a four compartment reservoir of about the same cubic inch capacity.

689. Q.—What are the names of the two brake cylinders?

A.—The empty cylinder and the load cylinder.

690. Q.—What is the name of the triple valve used?

A.—It is known as the K-2 L.

691. Q.—And the change over valve?

A.—It is known as the H-3.

692. Q.—How are they arranged on a car?

A.—About the same as for the standard brake, the empty brake cylinder is bolted to the four compartment reservoir and the triple valve and change over valve are bolted to the other end with a tube running through the reservoir from the triple valve to the brake cylinder.

693. Q.—What is the name of the large chamber of the four compartment reservoir?

A.—The auxiliary reservoir.

694. Q.—What are the names of the other three small compartments?

A.—The load reservoir, the take-up reservoir and the reduction reservoir.

695. Q.—When the equipment is in empty position, how is the brake system charged?

A.—Air from the brake pipe enters the triple valve in the usual manner and charges the auxiliary reservoir through the feed groove in the piston bushing; an additional charging port leads from the triple valve piston bushing to the change over valve through which the chambers containing the change over piston and the change over slide valve are charged to the pressure contained in the brake pipe.

696. Q.—Is there any movement of the change over valve?

A.—No, the pressure equalizes on both sides of the change over valve piston and a spring holds it in an inoperative position.

(To be continued)

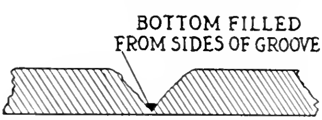
The Welding of Cast-Iron Most Suitable Metal for Learners to Start On

By J. F. SPRINGER

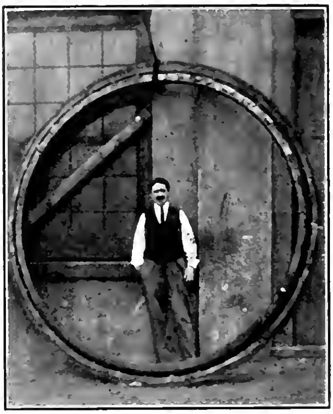
Cast-iron is rated as the easiest metal to weld with the oxy-acetylene torch. And by "cast-iron" is meant commercial gray cast-iron. It is a very good metal with which to begin one's practical knowledge. The ease of welding it is, no doubt, partly due to the comparatively moderate temperature at which this metal melts—about 2,400 degrees F. Wrought iron melts at 2,900, mild steel at 2,700, and medium steel at 2,600.

Whether one proposes to be a welder of iron and steel or to devote his attention ultimately to the non-ferrous metals, it is still necessary to make a start, and cast-iron is a good metal to use as a standard of reference.

To prepare for an easy job along this line, two pieces having a thickness of, say, 3/8 or 1/2 inch and a width of, say, 2 or 2 1/2 inches are beveled on the edges which it is proposed to unite. The edges may be given a slope of 45 degrees to the horizontal. When the two are brought together the result will be a groove, V-shaped in cross-section, having an angle of 90 degrees. The beveling may be done with a cold chisel. Attention may well be given to making fairly regular the two edges of the metal at the bottom of the groove. The object in view is to secure a sharp match between the sharp edges all along the seam at the groove's bottom, and by the narrowness of the crevice left prevent molten metal from dropping through. However, if the work rests on a steel slab, this prevention will be otherwise accomplished. Even where the under side of the joint is "in the air," one may, at need, rig a flat piece of metal to act as a temporary bottom. As to the faces of the groove, it is unnecessary that they be regular. Protuberances and cavities, if moderate in size, will make but little difference. It is well at this juncture to remember that one of the main objects of providing a groove is to facilitate getting the heat down to the bottoms of the two edges to be joined. As the "hot spot" is not far from the tip of the burner, the tip may have to be put part way into the V-groove in order to make sure of the right heating effect at the groove's bottom. It depends, in part, upon the size of burner employed.



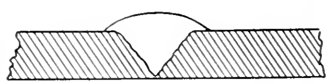
The sharp edges at the bottom of the groove may now be set to leave a very narrow crevice, say, of 1/8 inch in width. Underneath the crevice may be simply air. The V-groove will now be operated upon by the torch. That is, the "hot spot" is applied to the beveled surfaces at the bottom with the object in view of melting enough metal from the surfaces near the bottom in order to close the crack. The bottom of the V will now consist of old metal which has been melted in to itself. Let the operator make sure that the metal from the sides of the V runs well. This means, use heat. Unless the operator is left-handed, he holds the torch with his right hand. In filling in the crevice, let him recollect that there are two slanting sides, and that he is to melt metal from both. He may discover that he has a tendency to favor the left face. If so, this is undoubtedly due to the fact that he holds the torch in his right. Let him practice, therefore, in directing the flame against both faces—now this, now that. This may readily be managed by the wrist and hand.

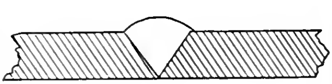


RING WELDED BY OXY-ACETYLENE.

The *welding rod* is held in the other hand. That is, a right-handed welder holds the torch in his right hand and the rod in the left; and *vice versa*, if he is left-handed. The material in the rod is sometimes of great importance. It is quite usual to employ a pure commercial iron, such as Swedish or Norway iron. However, a cast-iron welding job may be welded advantageously by means of a special material. This may consist of gray cast-iron containing a "high percentage of carbon and a still higher percentage of silicon."

It is well to understand this matter, not only in connection with the welding of cast-iron but as representative of variations in welding rod that may become necessary when welding non-ferrous metals. The high heat of the welding flame is quite competent to vaporize silicon in the work during the welding operation. This means loss of silicon; and this in turn means that the character of the gray cast-iron where the loss occurs may be changed. White iron is the material that may result from evaporating silicon from gray cast-iron. It is quite different from the body of the work, being quite hard and brittle. Ordinary gray cast-iron will contain, say, 3.10 per cent of carbon in the graphitic condition, and 2.00 per cent of silicon. There may be a small percentage of carbon actually combined with iron. Now consider the content of white iron. There may be no silicon at all and no carbon in the graphitic condition. The percentage of combined carbon—that is, of carbon actually combined with iron—may be very large. The highest percentage of combined carbon in tool steel is 2.00 per cent. But white iron may have 2.50 per cent. In general, when one is welding gray cast-iron, white iron will not be wanted even in spots. Silicon is the thing that prevents it from forming. Consequently, the welding rod may advantageously contain enough silicon to prevent itself from being partially converted into undesirable white iron and enough in addition to replace losses in the metal in the sides of the groove. Probably some silicon is lost from the rod through evaporation and some from the work. The rod should, if possible, contain enough to make up both losses more or less completely. High-class makers of welding rod should be able to inform customers and users of the content of the welding rod for gray cast-iron. If the soft gray cast-iron welding

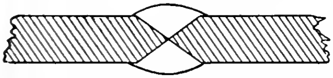




rod with a high percentage of silicon is not obtainable, the welder may substitute Norway or Swedish iron or an American pure iron.

Let us now return to our welding job. There has been, so far, no welding rod used. The bottom crack in the joint has been filled in with molten metal from the faces of the V-groove. This mode of filling can not be continued indefinitely. There is, in fact, a groove to be filled up with fresh metal. This comes from the rod.

A very important rule is now to be mastered. *Autogenous welding consists in adding molten metal to molten metal.* Very simple, isn't it? But one has to "watch his step" in carrying it out. It is an easy rule to break. When molten metal drops from the rod, the rule requires molten metal to receive it. Molten bits of rod must not fall on solidified metal. It is very easy to pay a good deal of attention to melting the end of the rod and but very little attention to melting the spot where drops of molten metal are to fall. *Molten metal to molten metal* is the welder's watchword. If he neglects it for an instant he has probably created a spot where there is some defect in the union of the particles. The "hot spot" of the



welding flame must be kept active at two things—(1) at melting the rod, and (2) at preparing a molten spot to receive whatever is melted off. If the beginner makes up his mind to this thing of adding molten metal to nothing else than molten metal, he is starting right, and is laying a good foundation for future success. This rule applies generally to all metals, non-ferrous ones as well as iron and iron alloys. There is a corrective. One may realize that he has let drop a bit of molten metal upon a spot insufficiently heated. The "hot spot" may be brought to bear and made to inject enough heat to penetrate to the insufficiently heated point and effect the desired interflow of the old and the fresh.

The groove is filled up, little by little, the welder simultaneously preparing a spot and adding fresh metal from the rod. The locations to be prepared are the side faces of the groove and rod metal that is already in place. The operator works along, attending now to this side and now to that. Finally, he has his groove fully occupied with metal from the rod. It is good practice to add something more than just enough to fill the groove flush with the top surfaces of the work. The welder may encroach a little to both sides and add a layer of new metal wider than the top of the V. He may also keep on adding new metal and form a rounded ridge.

The object in view is to increase the weight and quantity of metal at the seam. The metal actually in the weld may be less strong, both in tension and compression, than the normal metal in the work. This may or may not be undesirable. It depends upon conditions, etc. If, however, the full total of strength is required, it will be well to build up a rounded and widened ridge. The idea is simply this: If the metal at this point is inferior in strength, the desired total of strength may nevertheless be provided by providing enough metal. In fact, if it seems undesirable to add all the extra metal to one side, the work may be turned over and the seam built upon the other side as well.

Where the beginner simply desires to get started, he may try his hand at cast-brass as well as cast-iron. It is quite possible that the weld itself in the cast-brass work will be very inferior in point of the quality of metal. However, this will not be important if the whole is put on the scrap pile when the welder gets through. The rod for the brass work may simply be a bar of brass or a bunch of brass wire twisted together.

Railroad Electrification

At the annual meeting of the Engineering Institute of Canada, held recently at Ottawa, F. H. Sheppard, director of heavy traction, Westinghouse Electric & Manufacturing Company, made an able address on the advantages of railroad electrification from an economical and engineering standpoint, in the course of which Mr. Sheppard stated that the ability for service of electrical equipment as compared with steam is truly amazing. A very notable example is the service of the Grand Trunk Railway through the St. Clair Tunnel, the first year's operation being accomplished with a total delay of seven minutes. Among other examples may be cited the record of the Pennsylvania-New York Terminal locomotives, which over a term of years averaged approximately 100,000 miles per locomotive detention. The length of time out of service necessary to insure reliable operation is comparatively small —a common schedule for inspection of electrical equipment is at the end of 3,000 miles operation, while a much greater mileage is frequent, and there are individual records as high as 10,000 to 12,000 miles.

In heavy haulage particularly the capacity for service of a single electric locomotive is ordinarily equal to three or four of the heaviest steam locomotives. During an emergency shortage of power, for instance, on the Norfolk & Western Railroad, it was found necessary to retire from service four electric locomotives; sixteen of the heaviest Mallet engines were assigned to the division to take their place.

Railroad operation has naturally been built up and determined by the limitations of steam locomotives, involving the necessity for attention at approximately 100-mile intervals. Divisional and terminal points have grown up around these limitations, thus establishing conditions for assignment of train service, as well as engine labor. The absence of such limitation in the use of electric power secures great freedom in the operation of train service, so that it is entirely practicable to eliminate intermediate terminals, with the attending direct and incidental expense. On the Chicago, Milwaukee & St. Paul Railroad two such intermediate terminals on their 440-mile electrification have been eliminated.

The ever present necessity for increased efficiency in transportation has already brought about a very material increase in size of trains. With steam power this has been secured at great increase in size of locomotives, revision of line, reconstruction of bridges, etc. Undoubtedly, had electrification been available, much of this capital expenditure would have been obviated, owing to the flexibility with which electric power can be applied.

The steam locomotive, with its single boiler, of necessity requires in large powers great concentration in weight, this affecting directly bridge and track conditions. An electric locomotive, on the other hand, is essentially an aggregation of subdivided power, possessing the capability of increasing the number of driving axles to an unlimited extent. Electric locomotives are now built up to twelve driving axles, and a further increase is even contemplated. In multiple unit service, as is well known, the driving axles are distributed throughout the entire train, control of the individual motors being secured through pilot wires in an electric train line.

The saving of fuel due to the use of electric power is, of course, complete in the case of hydro-electric supply and is 50 per cent or more from steam electric generating stations. This considerable saving is due both to the great efficiency of steam generation in large units under the economical arrangements obtaining in modern power-houses and to the avoidance of losses at the locomotive itself. An electric locomotive consumes power in proportion to its load and only when working. A steam locomotive is notoriously inefficient at light loads and large quantities of fuel are consumed in preparation for service and in keeping the engine hot at standstill or when no work is being done.

Polishing for Brass.

Sift coal ashes fine and mix with kerosene oil to a thick paste; add as much air-slacked lime as can be conveniently mixed with it. Apply this polish to the bright parts, rubbing hard. Wipe off and polish with dry slacked lime. Whiting and ammonia mixed to a paste is another good polish for brass. Apply and rub dry.

Electrical Department

Schedule and Operating Conditions Affecting Electric Locomotive Operation—The Effect of Change of Gear Ratio on Tractive Effort and Speed

In the March issue curves were shown from which it is possible to choose, approximately, the electric locomotive suitable for a given service. Or the locomotive may be available and the work the locomotive can accomplish can be determined. We pointed out that these curves should be used for quick and approximate results and are not intended for use where the problem requires a careful study. In the latter case the procedure is to follow the speed time curve. We have previously pointed out that speed time curve is a graphical representation of just what the locomotive is doing under fixed service of grade conditions and load. The operation consists of a series of runs, the number depending on the number of stops which the train makes between the two terminals. If we had a line 32.5 miles long with 16 intermediate station stops and a running time of 1 hour 8 min. then there would be 17 cycles and each run could be shown graphically. For all practical purposes the typical run is all that is necessary. This typical run is the average run of the above 16 runs and would represent the conditions to be met. The length of run would be the average length, and the time the average time.

Under the above conditions the average distance for the typical run will be $\frac{32.5 \text{ (miles)} \times 5280}{17} = 10{,}094$ feet. The average time over this average distance will be $\frac{60 \times 68 \text{ (min.)}}{17} = 240$ seconds.

The speed time curve is made up of four variables, namely, acceleration, coasting, braking, and stop. A change in any one of these will change the schedule speed, the other three remaining the same; or for the same schedule a change in one variable may change one or all of the other three. In the study of electric traction one should have a clear understanding of these four factors and their relation one to the other. After discussing this relation we will take up the question of gear ratio and will explain what effect a change of gear ratio will have on the speed time curve. Many times the electric motor, as shown by the characteristic curves, is not suitable; the speed may be too high or again too low, but in many cases it can be changed to suit the conditions by changing the gear ratio.

One hundred pounds per ton tractive effort is required to produce an acceleration of one mile per hour per second. Other rates of acceleration are proportional. At low rates of acceleration, therefore, the tractive effort will be less, and hence the current taken by the motors will be less than for high rates. It naturally follows that the time will be greater to reach a certain speed; and moreover, a greater distance will be covered before attaining this speed. To put it in other words, the lower the acceleration the less will be the distance traveled in a give time.

When considering electric locomotive work, especially in long runs, the rate of acceleration is not an important factor, as only a small part of the total run is taken up by acceleration. In suburban service, however, where the schedule speed is high and where the stops are frequent and close together, the time gained or lost during acceleration may be an important item in the maintaining of scredules. This kind of suburban service is generally handled by multiple-unit trains and very high rates of acceleration are obtained, du to the large number of motor-driven axles.

As it takes longer with low acceleration to reach a certain speed the electric power must be kept on the train a longer time, so that to maintain a certain

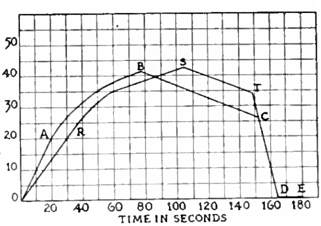


FIG. 1. SPEED TIME CURVES FOR SAME TYPICAL RUN SHOWING EFFECT OF CHANGE IN RATE OF ACCELERATION

schedule there must be less coasting. Also the train will be running at a higher speed when the brakes are applied. Fig. 1 illustrates this. A typical run is represented by OABCDE, the speed time curve. Let us assume a lower acceleration and the speed time curve ORSTDE represents what the typical would be under the lower acceleration condition. With a speed time curve the distance traveled is determined by the area under the curve. To put the two curves on the same basis, i. e., the same schedule, the areas must be equal. Due to the lower acceleration of the curve ORSTDE the area ORXBAO is lost and the power must be held on until point S is reached, at which point the area XSTCX is equal to ORXBAO.

The rate of acceleration influences largely the amount of power the train will take, especially in short runs. Generally, the higher the speed at which brakes are applied the greater the power consumption. This is obvious. The kinetic energy of a train depends on the speed at which it is running. This energy is stored up energy and is used to propel the car after the power is cut off. It is this stored energy which permits coasting. If the train has a constant rate of retardation or braking then the higher the speed at which the brakes are applied the greater will be energy dissipated at the shoes, and the greater must be the energy put into the motors to offset this loss.

The heat developed in the motors is dependent upon the square of the current passing through the motor. This is easily proven. The heat developed is the watts lost in the motor, and since watts is the product of amperes (current) and volts, the watts lost or heat generated equals current × volts drop in the motor. Ohio's law states that C (current) $= \frac{\text{E (voltage.)}}{\text{R (resistance)}}$ Substitute for the "volts drop in the motor" it is equivalent from Ohio's law, namely, E= CR. We then have $C \times (CR) = C^2R$. The resistance (R) of the motor remains practically constant, so that the heat depends on the square of the current. Increasing the acceleration increases the current peak and this increases the heating. With the increased acceleration, however, the power is on a shorter length of time, tending to reduce the heating, and it may be that the run using the higher acceleration will give the minimum heating. For any given length of run there is one rate of acceleration which will give minimum heating. Rapid acceleration affects the heating of the motors to a much greater extent in short runs than in long ones, as the high accelerating currents occur more frequently and form a larger proportion of the total time. The size of the motors for the locomotive are determined by the heating, so that with a given load and a given schedule larger motors are required as the stops increase.

The length of stop will have a decided effect upon the schedule speed and the power consumption, as a study of the speed time curve will show. If the stop is lengthened the point D must be moved nearer to point O, and in order to keep

the same area (must have the same area as the distance is the same and the area is proportional to the distance) the power must be kept on longer, there will be less coast, so that the power consumption and heating will be increased.

If the braking rate is changed the operation will be effected similar to the effects produced by a change in acceleration. In long runs a change in braking hardly affects conditions since the time is a small proportion of the total time of the run, but in short runs it becomes an important factor. It is advantageous to have a high braking rate. More coasting can be secured, resulting in lower power consumption and less heating of the motors.

The subject of the "gear ratio" is an interesting one. The gear ratio between the wheels and the motors determines the speed of the train. The tractive-effort is also affected by the gear ratio, assuming that the current to the motor is constant, and hence the torque is constant as the leverage is changed. The horsepower of a motor for a given current is constant. Horsepower is directly proportional to the product of the speed and the tractive effort, so that it follows that with a high speed the tractive effort is low. Therefore, to produce a given tractive effort on a certain rate of acceleration with high-speed gearing a much greater current must be used than is required with low speed gearing. High speed gearing will mean, then, that more power is required on grades and curves, but the time consumed will be decreased, which is an advantage of high speed gearing. A too low gearing can be used, resulting in such a small amount of coasting that the power consumption will be excessive. In general, a gear ratio should be used which will give the lowest speed required to maintain the schedule with a margin for making up lost time. In studying a problem and drawing up the speed time curve, sufficient coast should be allowed to take care of delays, so that the equipment can perform at a faster schedule with all conditions perfect. To change the motor curve from one gear radio to another is simple. The full lines, Fig. 2, show the characteristic curves of a railway motor drawn for a gear ratio of 21:66 with 33 in. wheels.

We will assume that the speed is too high, and that a 16-tooth pinion will be used. The new ratio will then be 16:71. In any gearing where the centers are fixed as in this case, the sum of the pinion and gear teeth is always the same keeping the same gear pitch.

As will be noted in Fig. 2 the curves are all drawn in reference to amperes per motor. At any given current the armature revolutions of the motor will be constant, so that with the 16 T pinion the revolutions of the axle, and therefore the speed, will be less than with the 18 T pinion. The speed will vary inversely as the gear ratio, the gear ratio being the ratio of

$$\frac{\text{Number of gear teeth}}{\text{Number of pinion teeth}}$$

so that in this problem the speed will vary as

$$\frac{\frac{66}{21}}{\frac{71}{16}} = \frac{3.14}{4.44} = .708.$$

By picking out various points along the speed curve and multiplying by the factor .708 a new speed curve (shown by dashes) is obtained. Since the speed has gone

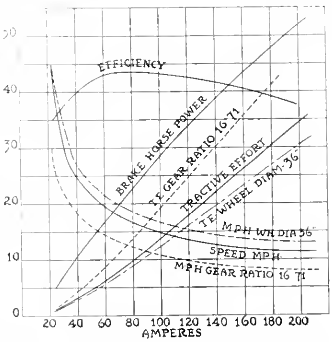


FIG. 2. CHARACTERISTIC CURVES—RAILWAY MOTOR—SHOWING EFFECT OF CHANGES IN GEAR RATIO AND WHEEL DIAMETER

down, and the horsepower must be constant for the constant current, it follows that the tractive-effort must increase, and it increases in direct proportion to the gear ratio. In this case in the ratio of $\frac{4.44}{3.14} = 1.41$. Applying this factor to the T E. curve a new curve is obtained, shown by dashes.

A change in wheel diameter will also affect the speed and tractive effort. Assume the original gear ratio and that the wheels are to be changed from 33 in. to 36 in. Changing to 36 in. increases the speed for a constant current and must therefore decrease the tractive effort. The factor for the speed is determined as follows, by the ratio of $\frac{36}{33} = 1.09$; and for the, tractive effort the inverse ratio namely, $\frac{33}{36} = .917$. Applying these factors to the curves, new curves are obtained, as shown by the dot and dash. If it is necessary to make changes for both wheels and gear ratio, the following formulae will be used, having in mind that

$$\text{the gear ratio} = \frac{\text{Number of gear teeth}}{\text{Number of pinion teeth}}$$

$$1.\quad \frac{\text{M.P.H. (1)}}{\text{M.P.H. (2)}} = \frac{\text{Gear Ratio (2)}}{\text{Gear Ratio (1)}} \times \frac{\text{Wheel Diam. (1)}}{\text{Wheel Diam. (2)}}$$

$$2.\quad \frac{\text{Tractive Effort (1)}}{\text{Tractive Effort (2)}} = \frac{\text{Gear Ratio (1)}}{\text{Gear Ratio (2)}} \times \frac{\text{Wheel Diam. (2)}}{\text{Wheel Diam. (1)}}$$

Internal Combustion Engines.

The great superiority of the Diesel engine is almost wholly obtained by the high compression which it is possible to give to the air before admission and ignition of the fuel oil to the cylinders. Compression is the chief characteristic of the internal combustion engine, and is the essential foundation of all heat engine cycles. The Carnot cycle is the ideal one owing to its perfect efficiency, but cannot be strictly adhered to in practice, since the engine becomes too bulky and heavy even for small powers, the weight of an engine of this type when working under the maximum pressure obtaining in the modern Diesel at about 17 tons per brake horsepower, whereas the modern engine only weighs at least one-hundredth of this figure. The original Diesel engine was intended to work on the ideal cycle. Although somewhat different from the ideal it is still the nearest approach to it, and hence its high state of perfection. The question as to the best ratio of compression to adopt in the various types was dealt with, and as was pointed out the advantages of increased compression in the smaller engines are somewhat nullified by the loss of heat through the comparatively large cooling surfaces of cylinder heads.

Nation's Gear Makers to Meet at Cleveland.

President F. W. Sinram, of the American Gear Manufacturers' Association, announces that their annual convention will be held at the Hotel Statler, Cleveland, Ohio, April 14, 15 and 16.

Papers will be presented as follows: "Gear Steels," by Dr. Parker, of the Carpenter Steel Company; "Proper Sizes and Materials for Gears"; "Worms and Worm Wheels," by a representative of the Timken-Detroit Axle Company.

The American Welding Society.

The first meeting of the above society was held on March 28, 1919, at the Engineering Societies Building, 33 West 39th street, New York. The society will merge the Welding Committee of the Emergency Fleet Corporation and the National Welding Council, and will include others who may be interested. It will also create and assist a bureau of welding and aid the principle of co-operation in research and standardization.

Items of Personal Interest

R. E. Line has been appointed roundhouse foreman of the Erie, with office at Kent, Ohio.

W. E. Beck has been appointed road foreman of engines of the Erie, with office at Meadville, Pa., succeeding Bert Hall, transferred.

J. H. Regan, assistant secretary of the Pressed Steel Car Company, has been transferred from the New York to the Chicago office of that company.

J. D. Muir has been appointed assistant works manager of the Angus shops of the Canadian Pacific at Montreal, Canada, succeeding John Burns, promoted.

C. J. Brodemer has been appointed assistant superintendent of machinery of the Louisville & Nashville, with office at Louisville, Ky., succeeding Millard F. Cox, resigned.

J. G. Fitzhugh has been appointed superintendent of safety and fire protection of the Gulf, Colorado & Santa Fe and associated lines, with headquarters at Galveston, Tex.

E. B. Hall has been appointed assistant superintendent of motive power and car departments of the Chicago & North Western, in place of E. W. Pratt, granted leave of absence.

G. H. Berry has been appointed master mechanic of the Atlanta division of the Louisville & Nashville, with headquarters at Etowah, Tenn., succeeding W. E. Hunter, transferred.

W. D. Manchester, formerly chief engineer of the Manistee & Northwestern, with office at Manistee, Mich., has been appointed purchasing agent to succeed E. H. O'Neill, resigned.

T. J. Lowe, formerly fuel agent of the Canadian Northern, Western lines, has been appointed fuel agent of the Canadian National, Western lines, with headquarters at Winnipeg, Man.

T. O. Sechrist has been appointed assistant superintendent of machinery of the Louisville & Nashville, with office at Louisville, Ky. The position of general master mechanic is abolished.

J. J. Haigh has been appointed assistant district manager of sales for the Chicago Pneumatic Tool Company, with headquarters at 175 First street, San Francisco, Cal.

A. H. Eager, formerly assistant superintendent of rolling stock of the Canadian Northern, has been appointed mechanical superintendent of the Canadian National, with headquarters at Winnipeg, Man.

Wm. F. Keisel, Jr., assistant mechanical engineer of the Pennsylvania, eastern lines, has been appointed acting mechanical engineer, with headquarters at Altoona, Pa., succeeding A. S. Vogt, retired.

H. A. English, master mechanic of the Central district, Canadian Northern, has been appointed master mechanic of the Central district of the Canadian National, with headquarters at Winnipeg, Man.

W. Y. Scott, formerly assistant signal engineer of the Boston & Maine, with office at Boston, Mass., has been appointed signal engineer, with headquarters at Boston, succeeding J. V. Young, deceased.

W. E. Hunter has been appointed master mechanic of Cincinnati terminals and Kentucky division of the Louisville & Nashville, with office at Central Covington, Ky., shops, succeeding C. W. Mathews, transferred.

Captain L. C. Dodge has been appointed assistant engineer of bridges of the Baltimore & Ohio, western lines, with headquarters at Cincinnati, Ohio. The Captain has recently been released from army service in the engineers.

Millard F. Cox, formerly assistant superintendent of machinery of the Louisville & Nashville, with office at Louisville, Ky., has been appointed vice-president and consulting engineer of the Louisville Fire Brick Works, Inc.

C. W. Mathews has been appointed master mechanic of Albany, Ala., shops, succeeding C. J. Bodemer. Mr. Mathews will have full charge of the shops and the mechanical department of the Nashville division south of Nashville.

J. M. Velasco, formerly local purchasing agent of the National railways of Mexico, at New York, has been appointed assistant to the general purchasing agent, with office at Mexico City, Mex., and F. P. DeHoyes is now purchasing agent at New York.

L. G. Roblin, formerly general master mechanic of the Canadian Government railways, Western lines, with office at Cochrane, Ont., has been appointed master mechanic of the Prairie district of the Canadian National, with office at Saskatoon, Sask.

A. Sutton, fuel and tie agent of the transcontinental division of the Canadian Government railways, has been appointed district fuel agent of divisions No. 1 and 2 of the Central district, Canadian National, Western lines, with headquarters at Cochrane, Ont.

Lieutenant William H. Hobbs, after returning from France, where he served with the 322nd Field Artillery, United States Army, has resumed his former position as assistant engineer on the Louisiana division of the Missouri Pacific, with headquarters at Monroe, La.

Major Huntly H. Gilbert, of the Ordnance Department, has re-entered the service of the Pressed Steel Car Company and Western Steel Car and Foundry Company, as assistant manager of sales for the western district, with office at 425 People's Gas Building, Chicago.

Morris H. Hawkins has been appointed federal manager for the Norfolk Southern, the Carolina railroad, and the Kinston Carolina railroad, with office at Norfolk, Va., succeeding J. H. Young, appointed assistant director of the division of operation with office at Washington, D. C.

Ezra S. Taylor, formerly assistant to the vice-president of the Pullman company, has been elected assistant to the president of that company, with office in the Pullman building, Chicago. Mr. Taylor was for several years general eastern agent for the company in New York.

George W. Rink, mechanical engineer of the Central Railroad of New Jersey, has been appointed assistant superintendent of motive power, with headquarters at Jersey City, N. J. Mr. Rink is a graduate of Cooper Institute, New York, with degrees of Bachelor of Science and Mechanical Engineer.

A. W. Preikschat, formerly assistant engineer of tests of the Pullman company, and later special representative in the purchasing department of the Steel Tube Company of America, has been appointed sales representative of the Liberty Steel Products Company, Inc., with offices in the McCormick building, Chicago.

C. W. Johnson has been appointed assistant manager of works of the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa. Mr. Johnson is a graduate of the Ohio State University. He entered the employ of the company in 1907, being appointed chief inspector of works, in which capacity he served until his recent appointment.

Charles N. Whitehead, formerly general manager of the lines of the Missouri, Kansas & Texas, has been appointed federal manager of the Katy system, with headquarters at St. Louis, Mo. Mr. Whitehead has had twenty-five years' experience in the employ of the Missouri, Kansas & Texas, and has held many positions in the operating department.

P. C. Cady, formerly office manager of the mechanical department of the New York Central at New York, has been appointed secretary of the International

Railway Supply Company, New York, which is the purchasing agent for the American Railroad Company of Porto Rico and the Trinidad Government railways, and also the export department of the Pyle-National Company. Mr. Cady has had an extensive experience in the mechanical and other departments of railways.

Herbert C. Hoover, formerly director general of allied relief, has been placed in personal control of all the railways in the states that formerly constituted the Austrian Empire. Mr. Hoover has placed the management of the details in the hands of the American Army engineers. It is stated that the five new states that have arisen out of old Austria all agree that the management of the railways and rolling stock be left in Mr. Hoover's hands. The duties also involve the care of the relief work throughout the territory.

W. O. Duntley has been elected president of the recently organized Duntley-Dayton Company. The new company has taken over the entire output of the Dayton Pneumatic Tool Company of Dayton, Ohio, and will continue operations in the pneumatic tool field. Captain C. A. Duntley, of the 27th United States Field Artillery, son of W. O. Duntley, has been elected vice-president. The offices of the company are located in the Westminster Building, Chicago, the New York branch at 295 Fifth avenue, and the Philadelphia branch in the Commercial Trust Building. The Dudley-Dayton company is extending its business beyond the output of the Dayton company, and is putting out a complete list of portable electrict drills and grinders, as well as an extensive line of other accessories, including rivet sets, chisel blanks, hose and hose couplings.

W. O. DUNTLEY

Annual Meeting of the Westinghouse Air Brake Company.

A. L. Humphrey Elected President. List of Directors.

At the annual meeting of the stockholders of the Westinghouse Air Brake Company, held at the general office of the company in Wilmerding, Pa., Mr. A. L. Humphrey, vice-president and general manager of the company since 1909, was elected president succeeding Mr. John F. Miller. Mr. Miller, after a service of thirty years, during which period he rose from the position of real estate agent for the company to its highest executive office, is desirous of being relieved of some of the active duties in the management of the Air Brake interests, but will remain, however, a member of the board of directors and hold the position of vice-chairman of the board with Mr. H. H. Westinghouse as chairman.

Mr. Humphrey, is known as one of the leading manufacturers in this country. He has been connected with the Air Brake Company since 1903 when he was appointed Western Manager with headquarters in Chicago. He came to Pittsburgh in 1905 as general manager of the Air Brake Works, and was elected a director of the company in 1909, when he was also given the dual position of vice-president and general manager. When the Union Switch & Signal Company was taken over by the Air Brake Company in 1916, Mr. Humphrey was also elected president of that corporation. He has been active in an executive capacity in all the other interests associated with the Westinghouse Air Brake Company, such as the Locomotive Stoker Company in Pittsburgh, the National Brake and Electric Company in Milwaukee, the American Brake Company in St. Louis, and the Westinghouse Pacific Coast Brake Company in San Francisco.

Arthur L. Humphrey, who was born in Buffalo, N. Y., after leaving public school, entered the railroad business as a machinist apprentice with the Burlington and Missouri River Railroad when he was seventeen years of age. He remained in the railway business until he came with the Air Brake Company for a period of twenty-five years. During that time he was successively machinist, foreman, master mechanic and superintendent of motive power. He held the latter position with the Chicago & Alton Railroad in 1903 when he began his connection with the Air Brake Company.

Mr. Humphrey's greatest triumphs as a manufacturer came through the war when he succeeded, in the completion of contracts for war material for the Allies as well as for our government, in establishing records that have not been surpassed. He not only put up factory buildings, installed special machinery and created an entirely new and separate organization, but he also finished the job on time without having a single piece rejected. When the United States entered the war, Mr. Humphrey received for the Union Switch & Signal Company a contract to produce 4100 aeroplane engines of the Le Rhone type, and government experts said, "it was the best rotary engine which had ever been constructed." Mr. Humphrey also acted in a consulting and advisory capacity to the government in Washington. He was industrial "Staff Expert" for Brigadier General C. C. Williams, Chief of the Ordnance Department, was a member of the committee on Labor of the Council of National Defense, as well as a member of the War Industries Board and the War Resources Committee in Washington.

Besides the election of a president, the stockholders also completed the regular business of the annual meeting yesterday by electing the following board of directors: Ben V. Becker, James D. Callery, E. M. Herr, A. L. Humphrey, John F. Miller, John R. McCune, John R. McGinley, Charles McKnight, M. S. Rosenwald, W. D. Uptegraff and H. H. Westinghouse.

Subjects to Be Reported on at the Conventions of the Master Car Builders, and American Railway Master Mechanics' Associations.

The variety and importance of the subjects on which the various committees of the Mechanical Associations of the American Railroad Association, including the Master Car Builders' Association, and the American Railway Master Mechanics' Association, will present reports are of such comprehensive scope, that it would seem as if the members were determined to make up for lost time occasioned by the fact that it is the first opportunity that the members have had in three years to meet in what may be called, full convention. During this period many improvements in general mechanical devices have been made, besides new inventions, and as may be expected, the sessions of the conventions will be more than usually interesting.

As an indication of the work before the conventions, reports from the following committees will be received and considered June 18-20, 1919, inclusive:

Arbitration, J. J. Hennessey, chairman. Standards and Recommended Practice (M. C. B.), T. H. Goodnow, chairman. Train Brake and Signal Equipment, T. L. Burton, chairman. Brake Shoe and Brake Beam Equipment, B. B. Milner, chairman. Couplers, R. L. Kleine, chairman. Loading Rules, J. J. Burch, chairman. Car Wheels, W. C. A. Henry, chairman. Safety Appliances, C. E. Chambers, chairman. Car Construction, W. F. Keisel, chairman.

Specifications and Tests for Materials (M. C. B.), T. M. Waring, chairman. Car Trucks, J. T. Wallis, chairman. Prices for Labor and Material, P. F. Smith, Jr., chairman. Train Lighting and Equipment, J. R. Sloane, chairman. Nominations, F. W. Brazier chairman. Tank Cars, A. W. Gibbs, chairman. Draft Gears, R. L. Kleine, chairman. Welding Truck Side Frames, Bolsters and Arch Bars, W. O. Thompson, chairman. Standard Blocking for Cradles of Car Dumping Machines, Jas. McMullen, chairman. Revision of Passenger Car Rules of Interchange, H. H. Harvey, chairman. Depreciation for Freight Cars, M. K. Barnum, chairman.

Election of officers, June 21, 1919. Committees' reports, June 23-25, inclusive.

Standards and Recommended Practice (A. R. M. M.), W. E. Dunham, chairman. Mechanical Stokers, A. Kearney, chairman. Fuel Economy and Smoke Prevention, Wm. Schlafge, chairman. Powdered Fuel, C. H. Hogan, chairman. Specifications and Tests for Materials (A. R. M. M.), F. M. Waring, chairman. Design and Maintenance of Locomotive Boilers, C. E. Fuller, chairman. Locomotive Headlights, H. T. Bentley, chairman. Superheater Locomotives, W. J. Tollerton, chairman. Design, Maintenance and Operation of Electric Rolling Stock, C. H. Quereau, chairman. Train Resistance and Tonnage Rating, O. P. Reese, chairman. Subjects, M. K. Barnum, chairman.

The general committee are as follows: C. E. Chambers, chairman; W. J. Tollerton, vice-chairman; Frank McManamy, C. B. Young, F. F. Gaines, I. S. Dowling, Jno. S. Lentz, M. K. Barnum, J. R. Gould, A Kearney, C. E. Fuller, T. H. Goodnow, J. W. Small, C. F. Giles, J. E. O'Brien, A. P. Prendergast, H. R. Warnock, Jas. Coleman, C. W. Winterrowd, J. E. Fairbanks, general secretary; V. R. Hawthorne, secretary.

American Locomotive Company.

The semi-annual report of the American Locomotive Company for the six months ending December 31, 1918, recently issued, shows a large increase in the gross business of the company, due to the new high records of production made at the larger plants of the company, together with the addition of the production of the Richmond and Montreal plants which, in the latter part of 1917, were being reorganized and converted from munitions to locomotive manufacture. On November 1, 1918, the company received from the United States Railroad Administration a contract for 500 standardized locomotives, and which are now in process of construction. Since that time extensive orders have been received from Canada, South Africa and Argentine Republic. The general results have been of the most gratifying kind, but it is hoped that the questions remaining unsettled before Congress of the disposition and financing of the railroads will meet an early settlement of such a kind as will aid materially in the readjustment of general business from a war to a peace basis.

Westinghouse Air Brake Company.

The annual report of the above company, and its subsidiaries, including the Union Switch & Signal Company, show that all of the constituent companies made substantial advances in net earnings, over the previous year, and each closed the period in a much stronger financial position than at its beginning. The company is thereby well prepared for the pause in business incident to the uncertainty of "reconstruction," and for the heavily increased demand for the product which seems sure to follow. The same gratifying results are reported from the houses in London, Paris, Turin and Petrograd. The latter, in spite of the deplorable conditions in Russia, maintains its status.

International Railway General Foremen's Association.

Wm. Hall, Winona, Minn., announces that through the courtesy of the Director General of Railroads, the above association will hold its annual convention in Chicago, Ill., September 2-3-4-5, 1919, the Hotel Sherman being the headquarters. The topics selected are: "Welding of Locomotive Cylinders, and other Autogenous Welding," "Safety First in shop and engine house service. The best method of application so that employees may be interested to practice the same," "Draft Gears."

Inspectors of Locomotives.

The United States Civil Service Commission announces an open competition for inspector of locomotives, for men only, on May 21 and 22, 1919. Applicants must be between the ages of 25 and 55. The salary is $3,000 per annum and necessary expenses when absent from headquarters. Applicants should apply for Form 1892, stating the title of the examination, to the Civil Service Commission, Washington, D. C.

Metal & Thermit Corporation Calendar.

The above corporation has issued a calendar for the current year, attached to a large map of the United States in colors. A feature of the fine map is a series of vertical lines showing the new railroad time zones, which went into effect in January, 1919. The combined calendar and map are a valuable addition to an office equipment. Copies had on application at the main office, 120 Broadway, New York.

Railroad Equipment Notes

The United States Navy Department, Washington, is inquiring for four rotary dump cars.

The Anaconda Copper Mining Company, New York, is inquiring for four 50-ton ore cars.

Mayer & Lage, New York, are inquiring for four to eight 20-ton, type E. S. T. platform cars for France.

The Greek government is reported in the market for 500,000 steel railway ties of 242 pounds weight each.

The Pennsylvania Equipment Company, Philadelphia, Pa., is in the market for 2,500 tons of 45-lb. relaying rails.

The American Locomotive Company states that it has received orders for 20 Pacific type locomotives from a railroad company in Argentina, S. A.

President Johnson of the Baldwin Locomotive Company has announced that the company has received orders from China for 34 locomotives, to cost about $2,000,000.

Robert Hudson, Ltd., Leeds, England, has ordered two Mogul type locomotives, weighing 37,000 pounds, and with 11 by 16 in. cylinders, from the American Locomotive Company, for service in Portuguese East Africa.

The Pennsylvania lines contemplate the following car shop improvements at Terre Haute, Ind.: Office building, paint shop, freight car repair shop, planing mill, storeroom, material and scrap bins and extension to power plant.

The Quebec Central railway has awarded contracts for a car shop with concrete substructure and a brick and steel superstructure to be built at Newington, Que. It will be 75 ft. by 225 ft. and one-story high, to cost about $42,000.

Ten of the largest locomotives in the world are being built for the Virginian railroad. Each weighs 449 tons with the tender, has high-pressure cylinders 30 inches in diameter, low 48 inches across and 20 driving wheels which develop 5,040 horsepower.

The American Locomotive Company has just closed orders for 62 engines for foreign roads. The largest order is from South African railways for 40 mountain type engines, of which 20 will weigh 97 tons and 20 94 tons. The engines for South African railways will be built at the company's Montreal plant and others at its Cooke works.

Rapid progress is being made in Serbia in the repair of the main Serbian railway which runs from Belgrade through Nish to Salonika, says a French wireless despatch from Salonika. It is hoped that the first trains will be able to run between the northern frontier and Nish before the end of March. All the bridges and many miles of rail were destroyed by the Germans and the Bulgarians. The repair of the telegraph lines paralleling the railway is nearly completed.

According to advices from the City of Mexico, the Carranza government has ordered the purchase of 200 passenger cars for the National Railways of Mexico. The cars will be bought in the United States and will be used to replace the equipment that was destroyed during the protracted revolutionary period. The government also plans to place a large order for freight cars in the United States in a short time. The shops of the railroad are building and repairing freight cars as rapidly as possible, but the additions do not begin to meet the demands of traffic.

The director general of military railways has 45,000 tons of steel rail, both Bessemer and open hearth, with the necessary angle bars, bolts, spikes, tie plates, rail braces, frogs, switches and crossings for sale. The rail is of the A. R. A. Type "B" 80-lb. section. The specification for the Bessemer rail is not given, but that for the open hearth is substantially the same as the A. R. E. A. specification as given in the 1915 edition of the manual. About one-third of this material is stored at New York (Kearney, N. J.), and the remainder at Norfolk, Va. Regional directors are asking the federal managers to see if any of this material can use any of this material.

The United States Railroad Administration during February delivered 127 locomotives to the railroads under Federal control. In addition to these there were also eight miscellaneous domestic and 164 foreign locomotives. Of these the most popular form was the Mikado, or 2-8-2 type, over one-third being of this type. It is also noted that this ratio in favor of the Mikado type has been particularly marked since the railroads were taken over by the government, the figures showing that about 950 locomotives have been constructed under orders of the Railroad Administration, of which 565 were of the Mikado type. It may be added that over 1,400 other locomotives have been constructed during the period referred to, but these were under contract previous to the railroads being under government control

Bulletins, Catalogues, Etc.

Landis Pipe Threading Machinery

Catalogue No. 25 for 1919, issued by the Landis Machinery Company, Waynesboro, Pa., presents in elegant form a descriptive and illustrated presentation of the company's fine products. The Landis chaser, chaser holder, pipe die head, threading and cutting machines, motor-driven machines, rotary pipe and nipple threading die head, machine accessories, chaser grinder, together with the names of parts, complete the publication. The illustrations, of which there are about fifty, are, like the company's products, the very best. The catalogue before us does not supersede No. 24, but rather supplements it, as the previous catalogue contains much matter concerning bolt-threading and nut-tapping machines, and screw-cutting die heads, which does not appear in the present catalogue. Copies of either may be had on application to the company's main office.

Railway Motor Cars

Reprint No. 73, issued by the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., contains a reprint of special papers: "Seeking the Best Railway Motor," by B. G. Lamme, Chief Engineer; "Principles of Economic Car Operation," by F. E. Wynne, Engineer in Charge of Railway Application Section; "The Application of the Ventilated Railway Motor," by S. B. Cooper, General Engineer; and "Acceleration of Cars," by Lynn G. Riley, Railway Engineer, all leading engineers in the service of the company. Space, or rather the want of space, prevents us from presenting even a brief digest of the valuable papers, but if it be true that they who read books run the world, it is assuredly true that those who read these papers can do more than run cars—they will know all about them. Copies to be had on application.

Accident Bulletin No. 7

The details of the collisions, derailments and other accidents resulting in injury to persons, equipment, or roadbed, arising from the operation of railways used in interstate commerce, published by the Interstate Commerce Commission, includes in its latest issue the records of the first three months of 1918. In comparison with previous years it shows a diminution of casualties, and this in the face of increased traffic is particularly gratifying and is the best proof that the safety first movement is being seriously taken up by the railroad men particularly and the public generally. Even the trespassers, who are still with us, are beginning to look both ways. Marcus Dow and others engaged in the good work are not laboring in vain.

Staybolts

The Flannery Bolt Company, Pittsburgh, Pa., announces with a degree of pardonable pride that the "Tate" Flexible Staybolt is the type of flexible staybolt recommended for use in the standard types of locomotives by the Standardization Committee of the United States Railroad Administration. The several "Tate" Flexible Staybolt assemblages to cover all conditions are illustrated, with tables giving the number and size of separate parts used in each type of boiler. The company also takes the opportunity to remind their customers that considerable expense is saved by ordering their supplies of "Tate" flexible bolts as far ahead as possible. Express shipments add to the expense.

Saving Coal in Power Plants

It is comforting to note that the Department of the Interior is saving paper by issuing in an eight-page circular a mass of valuable matter in regard to saving coal in power plants. In addition to the press matter in the Bulletin No. 2, there is a heat balance diagram showing the small portion of the heat developed by the fuel which is used in generating power. It appears that ten per cent runs the engine. The other ninety per cent goes up in the air, or sometimes heats a building. The circular advocates the heating of feed water to at least 200 deg. Fah. Government Printing Press, Washington, D. C. 5 cents per copy.

Graphite.

The current issue of *Graphite*, published by the Joseph Dixon Crucible Company, Jersey City, comes out in the early part of the year bright as a burnished cylinder. Machinery needs lubrication and graphite is lubrication. It cannot be carbonized or ignited. It does not give off explosive vapors. It does not clog discharge valves, nor will it accumulate dust or grit. It enables a large saving in the cost of lubrication, and avoids danger of explosion in air-compressor practice. Engineers are constantly changing their minds in regard to the best kinds of lubricating oils, but there is no divergence of opinion in regard to the merits of graphite.

Fuel Economy Chart.

The Railroad Service Division of the International Correspondence School, Scranton, Pa., of which Ed. M. Sawyer is manager and J. F. Cosgrove director, has prepared and published a Fuel Economy Chart, measuring 2 ft. 6 ins. by 2 ft. and suitable for framing. The detailed plan outlined and illustrated by drawings and diagrams is arranged to meet the requirements of a railway operating 1,000 locomotives. The personnel can be reduced or increased as occasion requires.

Railway and Locomotive Engineering

A Practical Journal of Motive Power, Rolling Stock and Appliances

Vol. XXXII — 114 Liberty Street, New York, May, 1919 — No. 5

The Turning Over of Five Thousand German Locomotives to the Allied Armies

Our frontispiece this month shows the truth of the old saying that "to the victors belong the spoils." In the present instance, however, it is not exactly spoils, but to a considerable extent a substantial restitution for damages committed by an unscrupulous foe, with interest added. In the demand of the allies for 5,000 locomotives and 150,000 cars from the crushed Huns, it must be remembered that in the terrific advance of the German army, the invaders took everything that they could lay their hands on, including 230 locomotives of the heavier type, and about 13,000 of the lighter type, besides 71,000 open and 20,000 covered cars. The Allies demand the delivery of 88,500 of the open and 40,000 covered cars, and others of special types, besides the 5,000 locomotives to which we have already referred.

The terms of the restitution have not been carried out as promptly as agreed upon. According to the original demands of the Allies, Germany should have delivered 2,000 locomotives and 50,000 cars in ten days. The new terms agreed on as to the extension of the armistice are giving opportunities to get easier terms in the question of delivery. Beginning on January 16, 100 locomotives were to be delivered daily. The number of full trains also called for 48, increasing to 70 daily, and all in first class condition. The German national railroads are credited with possessing 36,008 locomotives and 782,529 freight cars. As a matter of fact, there were only 30,700 locomotives available, and, according to statistics issued last October, there were 16,000 passenger cars, 12,000 baggage cars, and 459,000 freight cars. The remaining locomotives and cars were lost in consequence of the war, or are in occupied districts, or in allied or foreign countries. Locomotives that require repairs figured from 30 to 50 per cent. of the total. That was due to the strain put upon them by the war.

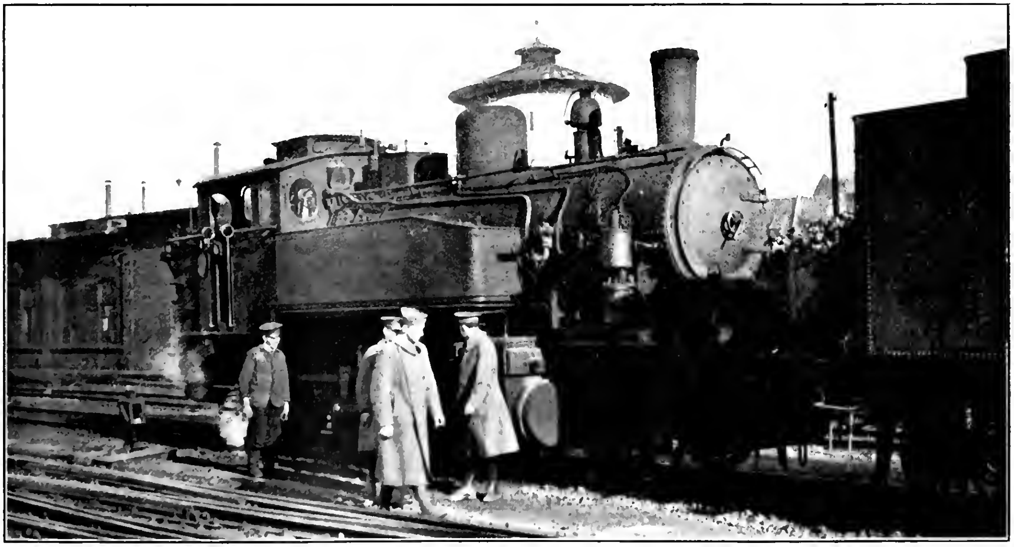


Photo by International Film Service.

GERMAN LOCOMOTIVES SURRENDERED TO AMERICANS.

The factories and roundhouses were not altogether to blame for the delay. The numerous strikes and reduced efficiency have made it impossible to accomplish the work demanded. The rolling stock was still further reduced through the necessities of demobilization, and the return of prisoners.

The Germans took from the Belgians and French the rolling stock of a lighter type than those in use in Germany, the latter having freight cars usually of a much larger tonnage than those of their neighbors. In 1912 it was noted that only about 45 per cent. of Belgian cars possessed a tonnage capacity of 15 tons or more, whereas 85 per cent of German cars have this capacity. In the restitution therefore the Germans are justly called upon to give more than they got. It must also be remembered that a not inconsiderable proportion of the rolling stock to be delivered was already in the hands of the Allies, as the Germans in their haste to get towards the Rhine left over 2,000 locomotives and nearly 100,000 cars in the districts since occupied by the Allied armies.

Meanwhile the work of repairs and transfer have been going on as rapidly as possible. The Allies are extremely strict in seeing that the repairs are properly done. American engineers have a preference in this work of inspection. The German working gangs are divided into three shifts in both the railway and private shops. Both the military and passenger traffic in Germany have been much impeded by the shortage of skilled men to attend to the running repairs and the operating of the locomotives. The German railway authorities have instructed all branches to reduce traffic 50 per cent. The manner of fulfilling this instruction is left to the direction of the branches. It has also been enacted that no one can use the railways without a special permit. This restriction has not been applied to the city of Berlin, but it may become necessary to insist upon a travel permit even there.

Coblenz has, so far, been the principal receiving station for the repairs and transfer of the locomotives, which are not only carefully inspected by the Allied authorities, but are given trial trips before being accepted. The same thorough inspection is made of the cars, so that in the near future both France and Belgium will find that their locomotives and rolling stock are in better condition than before the war. To these repaired locomotives, of course, are added the fine equipment furnished by the American and other manufacturers.

The damages to the railroads generally, and the bridges particularly, in the devastated region cannot be so speedily repaired, but they are also being repaired as rapidly as the limited means and material will permit, and will be settled for in the final accounting, so that what the Germans cannot replace they will have to pay for. The transportation conditions in France are being re-established with a degree of rapidity that is admirable, the assistance of the American and British engineers being of great service in the emergency, so that normal conditions will be resumed in the war-stricken zones long before conditions equally serviceable will be accomplished in Germany.

Our last illustration is a reproduction of a photograph of the staff of German engineers in charge of repairing the German locomotives that are being surrendered to the American engineers in keeping with the terms of the extended armistice. The view was taken at Coblenz, where the great bulk of the locomotives are being repaired. Some may think that they would not care to be seen in this bunch who must inwardly have been thinking their own thoughts naturally arising from the sad experience of passing through such a valley of humiliation, but there seems to be a supreme element of vanity in the Prussianized German mind that enables them to wrap themselves in a mantle of self-complacency under any condition.

Photo International Film Service.

RAILROAD YARDS AT COBLENZ WHERE GERMAN LOCOMOTIVES ARE BEING SURRENDERED TO AMERICAN ENGINEERS.

Photo International Film Service.

STAFF OF GERMAN ENGINEERS IN CHARGE OF REPAIRING GERMAN LOCOMOTIVES SURRENDERED TO THE AMERICANS.

The Necessity of Better Facilities for Car Repairs

Proper Repairs Impossible Under Present Conditions

An interesting discussion followed the address of J. J. Tatum, general supervisor of car repairs, United States railroad administration, at a recent meeting of the Central Railway Club, on the subject of "Unification of Inspection and Maintenance of Car Equipment." In the course of his remarks Mr. Tatum stated that "the necessity requiring certain things being done and issuing instructions to do them does not always mean they will be done, or that the instructions issued will be complied with. There is something more to be done than to only realize the necessity of doing things and issuing the instructions. The men in charge should be capable of not only issuing instructions but capable of knowing when instructions are being complied with. They should also be capable to the extent of knowing how to issue workable instructions and to select men who are capable of complying with their instructions. When selecting a man as Foreman Car Inspector or a Leading Inspector, it should be known that the man selected is not only capable of inspecting a car and know when it is properly inspected, but he should be as well capable of selecting men as Inspectors who are able to inspect cars properly.

"It should be considered just as serious and dangerous for one to remove a shop card from a defective car and permit it to go into service without necessary repairs being made, or permit a car to go into service with shop card on it, without repairs being made, as it would be for one to change a red signal to white, before an approaching train, without knowing whether or not the block into which the train is to move is safe and clear. In my opinion, one act is just as serious and just as liable to cause disaster as the other.

"Therefore, Mr. Railroad Manager, it is with you to see to it that your Car Inspectors are given your trains to inspect, with the time to make needed inspection and repairs. If this is not done you should be responsible for the failure of such cars not given the needed inspection, and not the head of the Car Department or his Inspector. It also lies with you to see that the Car Inspector's action, when shopping a car out for repairs, is given your full support, to the extent that should anyone remove a shop card from a defective car and permit it to go into service before necessary repairs are made, or place car in service with shop card on it, such person should be relieved from the service for the good and safety of all concerned."

F. W. Brazier, Superintendent of rolling stock of the New York Central, stated that in his opinion "the car department is not recognized by some as important as it should be. It is not generally known that the car department spends to maintain its equipment many millions a year more than the locomotive department. In 1917 the New York Central locomotive department spent about eight millions—the car department more than 17 millions. The car department, you can see, demands the best talent that can be gotten in supervision."

In speaking of the Master Car Builders' Association, Mr. Brazier said: "This is one of the oldest railroad associations there is in this country. It has done many important things, made laws regarding rules of interchange and created a good feeling among railroad men equally as well, if not more so, than any other organization. It is a well known fact that the M. C. B. Association, which has been in existence for over 50 years, and which has done so much for the standardizing of the equipment of the country, and its rules of interchange have been the means of moving freight promptly, yet many of the M. C. B. Rules were not mandatory but recommendatory. What was the result? Take for illustration the application of ladders on freight equipment: The M. C. B. Rules distinctly stated that the ladders (preferably) should be on the left-hand corner and 85 per cent. of the railroads of this country followed the M. C. B. recommendatory practice and placed their ladders on the left side, while 15 per cent. placed their ladders on the right, or as far from the left side as they could, so as not to be in accord with the 85 per cent.

"My suggestion would be that inspectors visiting all the railroads and looking after reports of reducing the number of so-called bad order cars, pay more attention to the upkeep of the equipment—to see and know that the work is done on cars, whether it be air brakes or other repairs, that they are done in a workmanlike manner and the practice of passing cars along from one road to another, hit or miss, should be stopped."

R. S. Miller, Master Car Builder of the Nickel Plate, referring to the unification of inspection and repairs, stated that he "would like to have clear instruction as to the serviceable car. We have had two or three interpretations of what a serviceable car is that are different, one or two of which came from Washington, and others from other sources. If we could get a clarified interpretation of what a serviceable car is, we would then be in a position to handle our joint inspection better. At Buffalo, cars are considered serviceable if suitable for any kind of lading, and are supposed to be in condition to be accepted at Chicago for loading, necessary repairs being made by the line loading them if required for grain. Chicago tells us few cars reach there that are not in bad order, and they refuse cars for all defects that cannot be repaired on running repair track. Buffalo claims that about all bad order cars come from Chicago. We had an interpretation in Buffalo that a car that was fit for loading with sewer pipe, brick, or anything of that kind, would be considered a safe and serviceable car, and if a road had an order in for some cars for grain it was up to them to take that car and put it in condition for grain. We have worked for some time on this principle, and have had considerable trouble with it, and that is one of the things I would like to have cleared up.

"Referring to the rules for examination of inspectors. The Master Car Builders have established a rule for that, I believe, that should be used instead of the heads of the car departments on various roads making their own or different rules."

A. R. Ayers stated that "periodic general repairs on locomotives was absolutely necessary for proper service. In car repairs, on the contrary, that particular feature had been overlooked. They almost never get a general repair. There are not car repairers enough in the country to repair all the cars that the inspectors would cut out when they ought to be cut out. We could not railroad a day if we did this. It is practically an impossible proposition. I do not mean that there is no way of getting on top of it, but primarily that we must follow out a policy of general overhauling and changing of standard construction of certain kinds of cars.

"It occurs to me that the final solution of the car problem is to have the various roads, acting on the basis of the Administration circular, develop detailed schedules for overhauling and applying betterments to certain groups of cars that they own and know are in defective condition and of weak design; they know where these cars are defective and they are the ones to take them back, not one or two at a time for repair, but by the hundreds. Then you will get your inspection and repair forces to the point where they won't be up against the defective construction of a car in the first place; they will only have to contend with ordinary running repairs, such as hose and air brakes and couplers and certain other things, and they will be in a position to cut the cars out when they become defective and get the equipment back in service promptly."

Mikado Type Locomotives for the Atlantic Coast Line Railroad

The Atlantic Coast Line has recently placed in service ten Mikado type locomotives, which were built by the Baldwin Locomotive Works. These locomotives, designated as Class M-2, present an interesting contrast to the Class M-1 Mikados, which were built for this line by The Baldwin Locomotive Works in 1911. A comparison of the leading dimensions of Classes M-1 and M-2 is as follows:

Class.	Cylinders.	Drivers, Diam.	Steam Pressure.	Grate Area.
M-1	22 x 30 ins.	56½ ins.	185 lbs.	54 sq. ft.
M-2	27 x 30 ins.	63 ins.	200 lbs.	73.4 sq. ft.

Water Heating Surface.	Super-heating Surface.	Weight on Drivers.	Weight Total Engine.	Tractive Force.
3,666	...	183,650	233,450	40,400
3,306	742	223,200	280,700	59,000

The relatively small total heating surface of Class M-2 is due to the fact these locomotives have combustion chambers with tubes 16 ft. 6 ins. long, while Class M-1, without a combustion chamber, has tubes 20 ft. 0 in. long. The increased grate area, and firebox volume and heating surface of Class M-2, however, more than compensate for this loss of tube heating surface. The Atlantic Coast Line has had a favorable experience with combustion chamber boilers on Pacific type locomotives, which are giving excellent results in the most severe class of express passenger service.

This road has comparatively light grades and easy curves, and the track is laid with 85-pound rails. The wheel loading of the new Mikados is close to the limit for rails of this weight, and the starting tractive force is comparatively high in proportion to the adhesion. The Coast Line handles a large amount of perishable freight, which must be moved at fairly high speeds; and the new locomotives can be efficiently used in such work as well as in heavy, slow speed service.

In accordance with Atlantic Coast Line practice all seams in the firebox and combustion chamber are welded, including the fire-door seam. The arch-tubes, five in number, are welded into the sheets, and the boiler tubes are welded into the back tube-sheet. Six combustion tubes are placed in each side of the firebox. The ash pan has two hoppers, and is of the Wine self-dumping type, which is standard on this road. The firebox is power-operated. Flexible stays are largely used in the water spaces, and the front end of the combustion chamber crown is supported on five rows of Baldwin expansion stays.

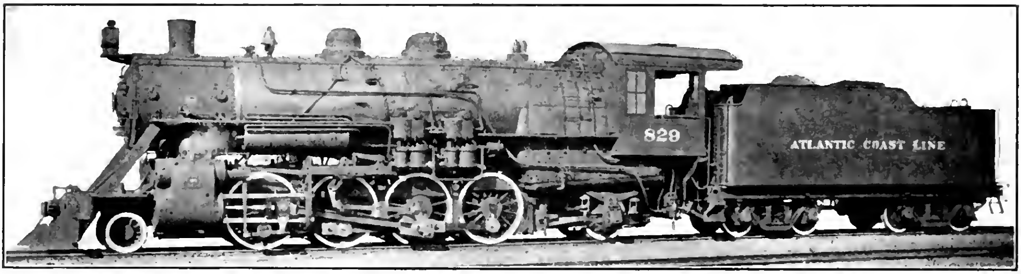
The boiler barrel is built with a conical course, which increases the shell diameter from 78 ins. at the front end to 88½ ins. at the dome ring. The dome is of pressed steel, in one piece; and it contains a Rushton throttle with auxiliary drifting valve.

The cylinders are fitted with gun iron bushings, and the distribution is controlled by 12-in. piston valves. These have light bodies of steel boiler plate, with bull rings and packing rings of gun iron. The valves are of sufficient length to permit the use of short, direct ports. Steam chest relief valves are applied. The piston heads are of cast steel, with brass wearing faces and gun iron packing rings of the Dunbar pattern. The piston rods are bolted to the cross-heads instead of keyed. Walschaerts valve motion is used, and the gears are controlled by the Ragonnet type B reverse mechanism. The valve motion work is fitted throughout with case-hardened pins and bushings.

The main frames are annealed steel castings, 5½ ins. wide; and the rear frame is of the Commonwealth cradle pattern. Cast steel driving shoes and wedges are applied, and the wedges are self-adjusting. The rear truck is of the Hodges type. The tender tank is carried on a one-piece frame of cast steel. The trucks are of the arch-bar type, with cast steel side frames and rolled steel wheels.

These locomotives embody, as far as practicable, details which interchange with those of other types of locomotives on the Coast Line. Further particulars in regard to the dimensions are as follows:

Gauge, 4 ft. 8½ ins.; cylinders, 27 ins. by 30 ins.; valves, piston, 12 ins. diam. Boiler, type, conical; diameter, 78 ins.; thickness of sheets, ¾ in. and ⅞ in.; working pressure, 200 lbs.; fuel, soft coal; staying, radial. Firebox, material, steel; length, 120⅛ ins.; width, 88 ins.; depth, front, 85 ins.; depth, back, 76½ ins.; thickness of sheets, sides, ⅜ in.; thickness of sheets, back, ⅜ in.; thickness of sheets, crown, ⅜ in.; thickness of sheets, tube, ½ in. Water space, front, 5 ins.; sides, 5 ins.; back, 5 ins. Tubes, diameter, 5⅜ ins. and 2 ins.; material, steel; thickness, 5⅜ ins., No. 9 W. G.; 2 ins., No. 11 W. G.; number, 5⅜ ins., 36; 2 ins., 240; length, 16 ft. 6 ins. Heating surface, fire box, 231 sq. ft.; combustion chamber, 86 sq. ft.; tubes, 2,954 sq. ft.; firebrick tubes, 35 square ft.; total, 3,306 sq. ft.; superheater, 742 sq. ft.; grate area, 73.4 sq. ft. Driving wheels, diameter, outside, 63 ins.; diameter, center, 56 15/16 ins.; journals, main, 12 ins. x 15 ins.; journals, others, 9½ ins. x 12 ins. Engine truck wheels, diameter, front, 31⅜ ins.; journals, 6 ins. x 10 ins.; diameter, back, 44 ins.; journals, 8 ins. x 14 ins. Wheel base, driving, 16 ft. 9 ins.; rigid, 16 ft. 9 ins.; total engine, 35 ft.; total engine and tender, 69 ft. 2½ ins. Weight, on driving wheels, 223,200 lbs.; on truck, front, 18,000 lbs.; on track, back, 39,500 lbs.; total engine, 280,700 lbs.; total engine and tender, about 475,000 lbs. Tender, wheels, number, 8; wheels, diameter, 36 ins.; journals, 6 ins. x 11 ins.; tank capacity, 9,500 U. S. gals.; fuel, 12 tons; service, freight.



MIKADO 2-8-2 TYPE LOCOMOTIVE FOR THE ATLANTIC COAST LINE RAILROAD. BALDWIN LOCOMOTIVE WORKS, BUILDERS.

The Development of the Locomotive

In the course of a paper read before the members of the New York Railroad Club on the subject of "The Contribution of the Engineers of the Railway Supply and Equipment Companies Towards Increasing the Efficiency and Capacity of Railway Operation," by W. E. Woodward, vice-president Lima Locomotive Company, in referring to the development of the locomotive, he said that "no branch of the railroad engineering has had a more noteworthy advance than locomotive designing, and probably a greater number of individual organizations contributed to the results than in any other field of railroad work. This development is the best example of a group of supply and equipment companies working together to refine and perfect one of the most essential elements in railroad operation. To the locomotive builder belongs the credit for improved designs and increased capacity of locomotives as a whole. To them is also due the credit for starting some of the improvements made for increased capacity and for improved economy. But to the supply concerns is due a large degree of credit for the patience and courage which have been required to put many individual improvements in the positions which they now occupy.

"Beginning a few years ago with such accessories as injectors, lubricators and headlights, the equipment companies have gradually extended the list until we now find fields of activities which are entirely specialized and the loocmotive builders and the railways turn to the engineering talent in these fields for their advice and recommendations. In certain lines entirely new developments have heen projected and carried out by the supply and equipment companies, as for example, the locomotive stoker, and the use of pulverized fuel. Thus we have come to see the supply and equipment companies no longer simply building and selling accessories, but occupying a much broader and more important field. As evidence of this it is only necessary to point out that some of the railway supply concerns have spent enormous sums of money to build up fine engineering organizations, with a view not only to refine their developments to the very highest degree, but also to forward the art from an entirely scientific standpoint. There is a question whether the public appreciates the spirit and energy back of the majority of these large supply companies which have made for better engineering and have been most important in bringing about the developments of which I speak. Any adequate consideration, therefore, of locomotive developments must recognize the contribution of the engineers of these companies. Both the builders and the supply companies have been working towards one end; increased safety of operation; improved efficiency and greater capacity for our locomotives.

"A measure of what has been accomplished is a history of locomotive developments in the past few years. You are all familiar with the advances in the size, weights and tractive power of locomotives. The thing, however, which we want to remember is what these larger sizes mean as an engineering development. They do not simply stand for so many pounds more of metal in the machines, so much larger boiler, or so many inches more cylinder diameter; weights of typical passenger locomotives have increased 50 to 75 per cent. since 1900 and freight engines in about the same proportion. Such advances would have been out of the question, had it not been possible to have taken advantage of engineering developments effecting increased economies which have more than kept pace with the increase in the size of the engines. Perhaps it would be more accurate to say that the engineering developments in the past few years have effected such economy of operation as to make possible these increases in size. This is the real measure of the advance and it is due to the combined engineering experience and work of the supply and equipment companies and the locomotive builders.

"Let me illustrate my statement by some test plant figures obtained from a good design of Consolidation locomotive built about 1904, and a modern design of Mikado locomotive built in 1915. We may regard 5,000 pounds of coal an hour as about the limit of a fireman for continuous work—I will take this as a basis for comparison. The Consolidation required 4,700 pounds of coal per hour to obtain an output of 1,050 horse-power, and this was about the limit of the engine. With the same amount of coal, the Mikado engine produces 1,900 horse-power. The Mikado delivered almost twice as much horse-power as the Consolidation for the same amount of coal and human energy. These are actual test plant figures, but the every-day experience of the railway man bears them out. It is because of this that railroads recognize that it *pays* to scrap light and obsolete locomotives or to reconstruct them on modern lines using the refinements and developments which have brought about these improvements.

"This class of developments can be grouped under three general heads: Improvements affecting combustion of the fuel, steam generation, and cylinder performance. Under the heading of fuel combustion are: the introduction of wide fireboxes with grate areas sufficiently large to keep the rate of combustion within economical figures. Making provision of proper air openings into the ash pan; an item which was for many years given little attention, but one of vital importance. A better knowledge of the principles of combustion which has led to the wide use of the brick arch and the proper proportioning of combustion spaces to grate area; the latter item involving the use of combustion chambers. Better draft conditions largely made possible by the use of outside steam pipes which came in with the superheater. Also improved front ends, stack and nozzle designs.

"Steam generation: Greater care in proportioning boilers to suit the cylinder horse-power. The boilers of many older locomotives under normal operating conditions were overtaxed and were consequently inefficient. Improved design of water spaces which insure good circulation of water in the boiler, in which result arch tubes are a material help. A better understanding of the relation of tube lengths to diameters which has eliminated inefficient tube heating surface and promoted the use of combustion chambers. Feed water heating, which is just now being introduced upon locomotives, the saving from which is now being carefully estimated.

"Cylinder performance: Superheating, the most important single element in the list. The introduction of Mallet locomotives, which superheating aided very materially in bringing into favor. Valves and valve motions. Also better proportions of steam and exhaust passages, particularly the latter.

"The importance of these improvements is evident by the following figures taken from the same engines as mentioned above. For every 5,000 pounds of coal the boiler of the typical Consolidation of 1904 delivered to the cylinders 26,000 pounds of steam. The Mikado locomotive, for the same amount of coal delivered 38,000 pounds of steam. The Consolidation locomotive to develop 1,050 horse-power in the cylinders required 26,000 pounds of steam per hour, whereas the Mikado developed the same horsepower with only 19,000 pounds of steam.

"Even with these improvements there was a well-defined limit to locomotive capacity set by the physical limitations of the fireman. The stoker and pulverized fuel gave the answer. Both of these developments have had and will have a far-reaching influence on locomotive designs. They have made possible sizes of locomotives not thought of before their introduction. At no distant date the impor-

tance of pulverized fuel will become more evident as this country is forced to practice greater coal conservation.

"Locomotives having a tractive power of 147,000 pounds compound and 176,000 pounds simple have been built and several designs are in operation in road service having a tractive power of over 100,000 pounds. Such work calls for coal, the demand at times running as high as 12,000 pounds per hour. Locmotives of the later class are hauling 3,100-ton trains over a division of 113 miles having 1.2 per cent. grades at an average running speed of 18.7 miles per hour. These figures prove better than any amount of argument the vital importance of the stoker on locomotive design and the possibilities of pulverized fuel.

"Along with these developments, directly effecting economy of operation and increased capacity, comes another class of improvements no less important, i. e., those which aim at increasing the safety and ease of operation and reducing the maintenance. Many developments in this class also more or less directly improve the economy of operation. For example, power reverse gears which permit the engineman easily to adjust the cut-off at any speed, while with the old style of reverse gear he would not dare to make a change. Who in this room would care to unlatch the reverse lever of a big Pacific type locomotive at 60 miles per hour? Also, automatic firedoors and grate shakers, contribute directly to improving the firing conditions and thus promote the economy of coal. In the safety class of developments may be mentioned electric headlights, improved connection between engine and tender, flexible staybolts, bell ringers, low water alarms, water glasses and improved cab fittings. In the class directly effecting maintenance are improved lubrication for cylinders and journals, self-adjusting driving box wedges, throttles, drifting valves and the application of cast steel parts. The use of cast steel has been extended to cover many elements in the locomotive which were previously built up of a number of parts, for example, truck frames, both engine and tender, engine frame cradles, tender frames and bumpers and even the two main engine frames have been made in one casting. Cast steel cylinders were produced some time ago. This extended use of cast steel is not only working towards the betterment of maintenance on account of the reduction in the number of parts and connections, but also means a saving of weight. Every pound of material which can be taken out of the running gear goes into the boiler where it is of the maximum use.

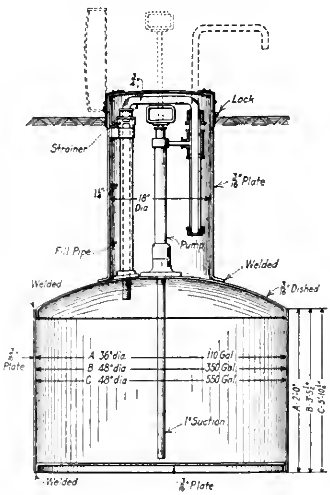
"About 1900 apparently the limit of permissible rigid driving wheel base had been reached and progress by the addition of driving wheels seemed stopped. This was met in two ways; by the articulated locomotive and by the lateral motion driving box used with engine trucks capable of large displacements, but with sufficient resistance properly to guide the heaviest engines.

"Thus one by one limitations have been removed, and one by one new elements effecting economy of operation, promoting safety or reducing maintenance have been introduced."

New Design of Storage Tanks

As is well known, the use of a storage unit for gasoline and signal oil in limited quantities is not new, but the demand for improved storage facilities has resulted in the development of a new storage unit which bids fair to come into general use. As shown in the accompanying drawing, the unit consists of a cylindrical, welded storage tank of minimum diameter of 36 ins., on which is mounted a dome 18 ins. in diameter and 2 ft. 9 ins. high. The dome contains fill and discharge pipes and a pump. The dome protrudes 6 ins. above the surface of the ground. The remainder of the apparatus is placed underground. The fact that the unit saves time, prevents waste and at the same time eliminates danger of disastrous fire or explosion, is what chiefly commends it to railway officials. The increase in the use of gasoline motor cars and gasoline engine driven air compressors for tie-tamping machines makes improved storage facilities imperative, and it was to meet this increase that engineers of the Wm. Graver Tank Works, Chicago, designed the unit.

The safety feature is one that will appeal strongly to the railroads. The use of the container has already been found to be a long step towards the reduction of fire risk. Toward this aim it may be stated that the tank is filled through a 1¼-in. pipe and is discharged by a pump through a ¾-in. pipe which telescopes in a 1½-in. pipe. This enables the operator to draw out the discharge pipe to a height convenient for filling a can or pail. When not in use the discharge pipe is turned down into the open end of the fill pipe. Where desired a hose attachment for the fill pipe is provided, the hose coiling into the dome when not in use.



DETAILS OF NEW DESIGN OF STORAGE TANK.

Water Power in Sweden.

Sufficient water-falls exist in western Norway to produce energy amounting to many million horsepower, and districts which were formerly considered barren and poor have suddenly become wealthy. The industrial organization of Norway was in full swing before the war, and the profits from shipping and fisheries have supplied capital for further development. Large factories have been built for producing carbide, cyanamide and nitrates. Electro steel works have been built at Lyster. Nine hundred thousand horsepower are available in the southern part of the Bergenhus district and a single waterfall in the northern part of the same district can yield 250,000 horsepower.

No systematic exploitation of waterpower has yet been made, as part is used by large industrial companies, and part by municipalities or individuals, for lighting, heating and power, especially for flour mills and agricultural machinery. Large quantities of electrical energy may be required for electric agriculture as promising results have been obtained, and still more is required for electrification of the railways. There are proposals for using electricity for the local shipping. Several districts have lately shown an increasing interest for the utilization of waterfalls and have, in many cases, decided to reserve the power for small industries, agriculture and for illumination. There can be no doubt that a carefully planned exploitation of the large water power available would make Norway a richer and more densely populated country.

Cleaning Steel.

Rub rusty steel with emery paper dipped in turpentine to remove rust. Polish with a fresh piece of emery paper and the result will be satisfactory.

The Assembling and Adjusting of the Walschaerts Locomotive Valve Gear

Last month we took the opportunity to call attention to the growing popularity of the Baker valve gear and furnished a few particulars in regard to its construction and adjustment, with a summary of added data in regard to the methods of treatment in case of breakages. We are already in receipt of letters of approval from a number of our readers in regard to the educational features of our work, and, while it is almost impossible to avoid repetition in such matters, it must be remembered that there is a constantly growing class of young men coming into the railroad service who are in need of instruction in matters that may be more or less familiar to the older and more experienced railroad man.

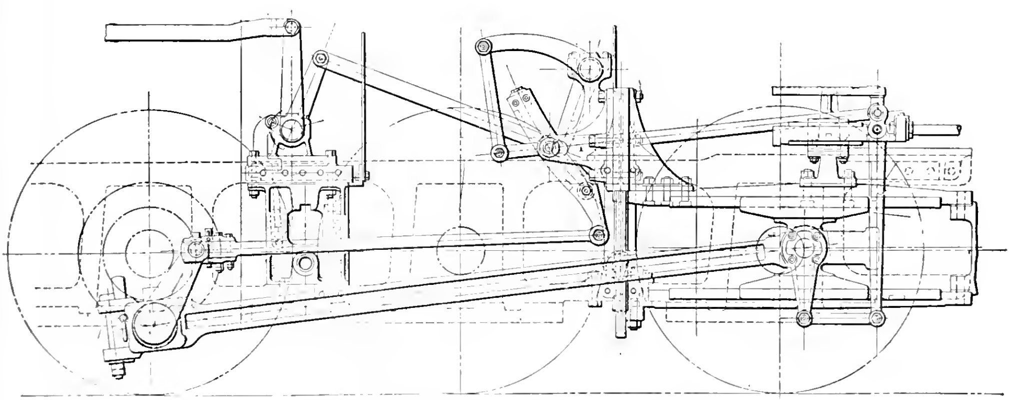
In this connection it occurs to us that some reference to the Walschaerts valve gear might be appropriate at this time. Such information was eagerly sought for when the valve gear came into popular favor, and there is a perennial interest in this particular part of the mechanism of the modern locomotive. The importance of its exact construction and the maintenance of its correct adjustment cannot be overestimated. Its effect on the increase of motive power and the saving of fuel has been shown to be of surpassing importance, and hence it is the duty of every railroad man engaged in the running and management of the steam engine to familiarize himself with the details referred to, but to endeaver to keep in the forefront of such knowledge as may come from the gathered experience of others.

Assuming that the details of the various parts are, properly speaking, the work of the constructing engineer, it is safe also to assume that they are nearly always correct, and it only remains for the skilled mechanic to continue in the same spirit of exactness supplementing the work of the constructing engineer, whose work being merely on paper, is easily rectified, while the parts in the hands of the mechanic being of more substantial material is not so easily changed, although the actual need of exactness is equally great, requiring that all parts should be checked and placed in position as shown in the blue prints.

The locomotive should be leveled and the saddle on main driving box should be blocked upon frame the distance about what the engine would settle when in service; the rollers should be placed under the main wheels and should be adjusted so that the main driving boxes are up against the spring saddle so the tension will hold main journal in place in driving boxes.

The reverse bar should be put into the next to last notch in forward motion (this extra notch to allow for the expansion), the wheels should be rolled forward to get the full travel of the valves and also to get crosshead travel. The main rod should be corrected to proper length, then place reverse bar in the last notch in back-up position, then roll wheel backward, get full travel of valves and prove travel of the crosshead (this to be used when proving cut-off). Combine the forward and backward travel on each side, and if found to be the correct amount, this would indicate that the quadrant may be considered correct.

If too much travel is shown in forward motion and not enough in back-up motion, this change should be made by shortening the long reach rod to suit, or vice versa; or should one side be shorter than the opposite side, this should be corrected by changing the radius bar hanger on Walschaerts gear. If the total travel is found to be greater than required amount, change by moving the stops toward center of the quadrant, or if trâvel is found to be less than required amount add notches to quadrant. When corrections have been made, place reverse bar in center of the quadrant thus placing the valve gear neutral; roll wheels forward, marking travel of the valve on the valve rod (this travel indicates constant lead and lap of valve). While getting this travel the dead center should be taken. On each dead center a tram should be placed in the center of eccentric rod bolt at links and a mark made on guide, if the mark made by tram when engine is on forward center is ahead of one made when engine is on backward center, the eccentric should be moved toward center of driving axle until tram point is in middle of the two points on guide. If mark made by tram when engine is on forward center is back of one made when engine is on backward center, eccentric should be moved from center of driving axle until tram point is in middle of two points on guide. The openings of valve should now be taken and checked with the lead and lap travel and if found out of center, valve stem should be corrected, making lead equal on each end.



WALSCHAERTS VALVE GEAR APPLIED TO LOCOMOTIVE.

Place reverse bar in next to last notch in quadrant in forward motion, roll wheels forward and catch each dead center, marking the valve stem, place reverse bar in last notch in backward motion, catch each dead center, marking the valve stem, change eccentric rod to divide marks made on valve stem.

The ratio of change on the Walschaerts

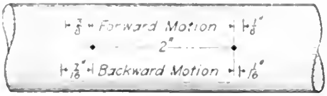


FIG. 1

valve gear is (valve travel divided into diameter of circle of eccentric; example, Valve travel is 6 inches, diameter 18 inches, Ratio 3 to 1) 3 to 1.

Prove engine by catching on each center in both directions. Place reverse bar in 10th notch of quadrant in forward motion, roll wheels forward. When tram points are on line of valve opening, stop rolling and measure distance between cross-head and travel, mark on guide, marking this distance down some convenient place, doing this on all points of both forward and backward motion. If forward motion on right side totals 36 ins. (that is if back end is 19 ins. and front end 17 ins.) and left side totals 34 ins., this should be corrected by lengthening radius bar hanger on the Walschaerts gear on left side.

As before stated, the back end is 19 ins. and front 17 ins.; corrections should be made by lengthening eccentric rod (mark valve stem and guide at crosshead, then move crosshead 1 in., and mark valve stem; if found that valve stem has moved 1/16 in. to the crosshead's 1 in., this will be the proper ratio—3/16 in. It may be added that these general instructions refer to locomotives having inside steam admission.

It may be well to remember that among the earlier locomotives equipped with this valve gear there was not that degree of nicety in setting the eccentric crank which now obtains. Neither was the correct length of the main rod always maintained

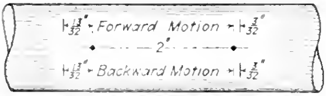


FIG. 2

with that degree of exactitude which is very essential to the proper position of the valve. The location of the eccentric crank at right angles to the main crank, and the maintenance of the main rod at the length specified by the constructing engineers are prime requisites, and any departure from the exact position of the former or the length of the latter leads to a wilderness of problems that are difficult, if not impossible, of solution.

It will also be observed that, no matter how much care may have been taken in the construction and assembling of the parts, slight variations will manifest themselves in the valve openings and with that peculiar aptitude to an increase in error in mechanism as well as in all other things, the variations from the exact point desired will generally show some increase after the locomotive has been in service a short time. This is to be expected, as the bearings naturally adjust themselves to the line of least resistance, the high tension and constant reversions of pressures on the slightly flexible mechanism show their inevitable result at the extreme end of the moving parts, and affect the valve openings. In the event of a slight increase or diminution of valve opening at either front or back steam ports, nearly all valves of the piston variety are adjustable by the use of liners in the valve stem. This, of course, necessitates the removal of the valve to insert or withdraw the liners required to equalize the position of the valve.

After this has been accomplished, assuming that there is a variation between the amount of valve opening on the forward and backward motions and supposing that the engine is on the forward dead

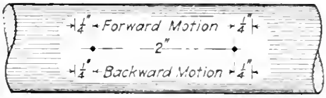


FIG 3

center on the left side and the amount of lead or opening of the valve should be increased, the valve must necessarily be drawn back toward the link. If the engine is in the forward motion with the link block in the bottom of the link this will necessitate a shortening of the eccentric rod, and on removing the pin connecting the forward end of the eccentric rod from the link arm, allowing the rod to remain in position, and moving the valve the required distance, it will be seen by the variation in the edges of the hole in the link arm from that of the eccentric rod how much the eccentric rod would require to be shortened.

This method, however, is not entirely to be depended upon, as there is always some lost motion both in the valve and radius rod connection, as well as in the central pivot upon which the link is suspended. These, in addition to the link block, would admit of a slight movement backward or forward of the extreme point of the link arm without showing any motion of the valve. Generally speaking, the eccentric rod would require to be shortened at least twice as much as the amount required in the opening of the valve. The exact ratio can be determined by measuring the distance from the central stud upon which the link oscillates to the center of the link block, and supposing this distance to be nine inches, then measuring the distance from the central stud to the center of the link arm connection with the eccentric rod, and supposing that to be eighteen inches, it

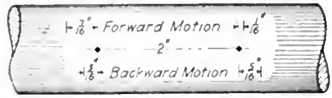


FIG. 4

will thus be seen that the eccentric rod must be shortened twice the amount that we desire to move the valve or increase the opening the required amount.

While these may properly be ranked among the simpler problems arising in the necessities of rectifying the Walschaerts valve gear, it more frequently happens that the variations arising both in the original adjustment and the subsequent discoveries are of a more intricate kind, and for the better and fuller elucidation of valve conditions in actual practice some diagrams are appended that have been taken by experienced mechanics in leading locomotive shops: The dots on the diagrams represent prick punch marks on the left side valve stem marked by a suitable valve tram from some convenient point and showing the exact point of valve opening with outside admission. The adjacent lines show the irregularities in the lead when the engine is on the dead centers. Giving our attention to Fig. 1, it will be noticed that in order to nearly square the lead, the valve must be moved ⅛ in. ahead in the forward motion, and on the back motion it must be moved 3/16 in. ahead. As the errors in the two motions occur in the same direction, it follows that the greater one partially neutralizes the effect of the lesser, and that the combined average error will be the difference between the two, that is: 3/16 in. minus ⅛ in. equal 1/16 average error. In order to di-

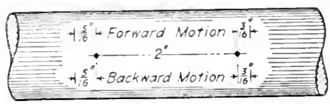


FIG 5

vide this average error of 1/16 in. equally about a central point, it will be necessary to move the valve one-half this amount, or 1/32 in., in this case 1/32 in. back in the forward motion. The eccentric rod must be shortened 1/16 in., in the proportion of two to one, to move the valve this distance. The markings on the stem will then show as in Fig. 2.

The forward and backward motions having thus been equalized, it only remains to square the lead for the front and back for both openings. This can be accomplished by lengthening the radius rod 5/32 in., the difference between the two openings, and the valve openings will be equalized as shown in Fig. 3.

It should be constantly borne in mind that other details of the gear should be observed, as, for instance, the exact length of the reach rod, which should be such as to bring the link block at equal distances from the central point of suspension when the reverse lever is in either the extreme front or back notches. Any marked variation from this equalizing of the link block with its attached radius rod necessarily affects the location of the valve, and the aptitude to look for remedies in the wrong direction would only lead to further error.

Referring further to valve markings that may show a more complex variety of markings than in the foregoing, assuming that the tram markings may show as in Fig. 4, it will be observed that the errors occur in opposite directions, and consequently any change in the valve liners would merely augment the error. The combined, or average, error equals ¼ in., and to divide this error equally about a central point it will be necessary to move the valve one-half the amount, or, in this case, ⅛ in. ahead in the forward motion. This will necessitate a lengthening of the eccentric rod ¼ in., in order to move the valve ⅛ in. The markings will then show as in Fig. 5. In order to square the openings as before it simply remains to move the valve ahead 1/16 in., and this may be done as already described in the previous experiment by lengthening the radius rod 1/16 in.

From the foregoing it will be ovserved that the errors in forward and backward motion are equalized by changing the length of the eccentric rod; and the lead can then be squared by changing the length of the radius rod the necessary amount as has been already described.

It may be added, in conclusion, that while these changes may occasion departures from the exact dimensions presented in the blue prints usually furnished by the constructors, they do not materially affect the organic structure or action of the valves, but merely tend to aid in rectifying the variations in the mechanism where circular motion is changed into linear motion, and at best are merely hints in the direction of attaining that degree of exactitude essential in the economic use of steam. Experience, at best, is slow in the complete mastery of any art, and it will be found that even guided by the experience of others, all approaches to perfection are always difficult of accomplishment.

Consumption of Fuel in Freight and Passenger Service

Scarcity of Data a Marked Feature

The Fuel Conservation Section, Division of Operation, United States Railroad Administration, recently issued a resume of the fuel consumed in freight and passenger service (mixed and special trains not included), this information set forth in two separate statements: one covering the calendar years 1916, 1917 and 1918 compared; the second statement covering the last six months of 1917 and 1918 compared.

In making the comparison for the three-year period, a most unfortunate lack of operating statistics, more particularly covering the roads located in the Eastern and Southern Regional Districts, is shown by these statements, the great majority of the roads not compiling gross ton miles handled in freight train service, making it impossible to calculate the consumption of coal on the basis of the accepted unit, the gross ton mile; any attempt to obtain the average weight of train similarly unobtainable.

In the comparison covering the last six months of 1917 and 1918, a somewhat more complete result was made possible by using in some instances, statistics covering a four-month, and a five-month period. The information contained in the two statements represents the following percentages of the total mileage of all the roads controlled by the Railroad Administration in the several Regional Districts and collected from the available data secured:

	Years 1916, 1917 and 1918. Per Cent.	Last Six Months 1917 and 1918. Per Cent.
Eastern Region—		
New England District	36	36
Central District	56	57
Ohio-Indiana District	65	65
Total, Eastern Region	53	54
Allegheny Region	66	66
Pocahontas Region	15	15
Southern Region	46	70
Northwestern Region	67	57
Central Western Region	97	98
Southwestern Region	97	97
Grand total, all regions	67	74

In making a comparison, we find from the totals available, that the pounds of coal per 1,000 gross ton weight miles increased in 1917 over 1916 4.6 per cent; with a similar increase in passenger consumption on the basis of pounds of coal per passenger car mile of 4.9 per cent.

During the calendar year 1918, when taken as a whole, there was a limited improvement in the unit fuel consumption. The fuel used in freight service on a gross ton mile basis during the year 1918, as compared with the year 1917, decreasing but 0.6 per cent; the pounds of coal per passenger car mile decreasing 0.5 per cent.

This period embraced the extraordinary severe winter weather suffered in January and February, 1918, when heavy snowfalls and loaded car congestions occurred throughout the whole Atlantic Coast region. This unfortunate condition was intensified by the wholesale enlistment of the more skilled railway employes, the railroads also furnished with what perhaps represented the worst average quality of fuel ever placed on locomotives. Thousands of tons of coal were used to keep engines alive while standing on congested roundhouse tracks; this desperate situation met in some instances by the unloading of lump coal from cars to the ground alongside of the freezing locomotives, exposed fires built and maintained to prevent a complete cessation of roundhouse terminal activities.

With the return of something approaching more normal operating conditions, supplemented by the delivery of a better grade of coal, and reinforced by the efforts of operating officials along the lines laid down by the Fuel Conservation Section, a decrease in the unit consumption of fuel is shown for every district from which information was sufficiently complete to make a total for such regions possible; the decrease in fuel consumption reaching the maximum in the Central District of the Eastern Region, the roads in this district for which information is available showing an average reduction in freight unit fuel consumption of 9.2 per cent, and in passenger train unit consumption of 7.1 per cent, the total reduction in all regions as shown by available statistics 5.5 per cent in freight train service, and 3.2 per cent in passenger service.

Bankers Discussing the Railroad Problem

Solution Expected in the Near Future

The solution of the railroad problem is engaging the minds of statesmen, railway magnates, editors and bankers. Out of this maelstrom of forces intellectual and financial some solution should come. The present pressure is so clamorous for money that it is well to give the bankers a hearing. If the security is substantial the bankers will furnish the needed funds, and the members of Congress can take a rest and give other people a rest. As we proceed to press the bankers are in session, and Allen B. Forbes, chairman of the Railway Committee of Investment Bankers' Association of America, is seeing that the bankers are being well taken care of at the Metropolitan Club.

The committee is composed of seventeen bankers. They include W. H. Porter, of J. P. Morgan & Co.; Charles S. Sabin, Frank A. Vanderlip, who is in Europe and will be represented by Charles E. Mitchell, president of the National City Company; Otto H. Kahn, George M. Reynolds and James B. Forgan, of Chicago; Breckenridge Jones, of St. Louis; Robert Winsor and John E. Oldham, of Boston; A. H. S. Post and William G. Baker, of Baltimore; George H. Frazier, of Philadelphia; Warren S. Hayden, of Cleveland; H. C. McEldowney, of Pittsburg, and Frank B. Anderson, of San Francisco.

It is expected that some of the bankers who will attend will have rather well defined suggestions for solution of the railroad problem to lay before the committee. It is understood that John E. Oldham, of Merrill, Oldham & Co., of Boston, has elaborated a scheme for merging all the railroads into thirteen major systems, which would be privately owned and operated. Under the suggested arrangement the New York Central would absorb all the lines in the Northeastern part of the country excepting the New Haven, taking in the Boston and Albany, Boston and Maine, West Shore, Nickel Plate and others in its zone.

A second group would be formed around the Pennsylvania, which would absorb, besides the New Haven, the Delaware and Hudson, the Delaware, Lackawanna and Western and the Erie. A third would embrace the Baltimore and Ohio, around which would be grouped the Reading, Lehigh Valley, Central of New Jersey, Norfolk and Western and Chesapeake and Ohio.

The so-called Hill roads would form the basis for a group in the Northwest which would take in the Northern Pacific, the Great Northern, and the Chicago, Milwaukee and St. Paul. Further south the Harriman lines would form a group with the Union Pacific as its heart. This would comprise part of the Southern Pacific system.

In the Southwest, Missouri, Kansas and Texas, Texas and Pacific, Missouri Pacific and other roads would be merged. Illinois Central would form part of a Mississippi Valley system. On the Atlantic coast the Atlantic Coast Line, the Seaboard Air Line and the Louisville and Nashville would be merged.

Walker D. Hines, director general of railroads, has a plan for settling the problem. This is his plan:

Return the railroads to private ownership, but limit the profits to a certain percentage—probably 6 per cent.—and give the government part of all earnings above that amount.

Create out of the 170 railroads which the government took over not more than ten or twelve big new railroad systems. Make each system a combination of some strong and some weak roads.

Get a new basis for valuation of the lines, based partly on their actual physical worth and partly on their proven earning power. Give the stock and bondholders new stock or bonds in accordance with the resulting capitalization of the railroads. Let the government guarantee to the stockholders a moderate rate of interest on their investment. Have the government represented on every board of directors, and let these government directors form part of the rate-making body, whatever it may be (not the present Interstate Commerce Commission, probably).

Mr. Hines believes that no more rate increases will be necessary for the next twelve months. He also believes that government operation during the war was thoroughly justified, that the results have been about as satisfactory as any one could expect, and that rates would have gone a lot higher and service been poorer under private control. "War conditions would have made private operation impossible," he says. "If it had been attempted, the results would have been a great deal worse than anything which we have seen."

Mr. Hines will ask the new Congress for the $750,000,000 which the last one failed to appropriate, and a good deal more. However, not all of this is an actual loss to the country. About $550,000,000 will ultimately be returned to the government, being paid back out of earnings.

"It is quite natural that the railroads should make a bad financial showing during the first six months of 1919," Mr. Hines declares. "Traffic has been far under normal, due to a variety of causes, and operating expense has been far above normal, due to war causes which still persist. One of these has been the cost of inexperienced labor. As the experienced railroad men come back from France to their old jobs they will help to cut this cost. It is true that we have increased the wages of our 2,000,000 employees, but such increases have been no more—not as much as a rule—than all sorts of other industries have given. Even if we hadn't taken over the lines, the increases were bound to come. A great proportion of all railway labor was badly underpaid before the war. We are even yet equalizing the increases and stabilizing labor at a fair level."

F. J. Lisman has a plan. We do not know Mr. Lisman, but he insists that the railroads should be returned to their owners at once, and the railroads are to be revalued. A careful and fair physical appraisal is to be made by regional valuation boards of representative character. (Mr. Lisman thinks the present physical valuation being undertaken by the government is unduly harsh.) The known earning capacity of the road is also to be "capitalized" at a basis of 6 per cent. Then an average will be struck between these two sums and will be the valuation of the road (except that if the earning power can be greatly increased in the future through expenditures or otherwise, it may be added in, year by year, over the period of time required).

If the railroad rates should persistently show more than 7 per cent profit, the regional Interstate Commerce Commission will lower them. If they persistently show less than 5 per cent profit, the regional commission will raise them. The states of the Union would have no powers to alter rates, and all railroads would be under federal charter. If the business men of a community thought their rates too high, they would appoint a committee of two to meet with a similar committee of two from the railroad, and fight the matter out, with a fifth man introduced if needed to settle the matter. Wage disputes would be arbitrated in the same way.

Each company would have nine directors, five of whom would represent the stockholders, two the government, and two the workers. The latter would be elected only from workers at least ten years in active service. All terminals would be used jointly, and terminals owned privately, not by railroad companies, would be bought and the stock divided among the companies using them. A new United States railroad court of appeals would also be established that would be armed with full power to settle all kinds of disputes.

War Record of the French Railways

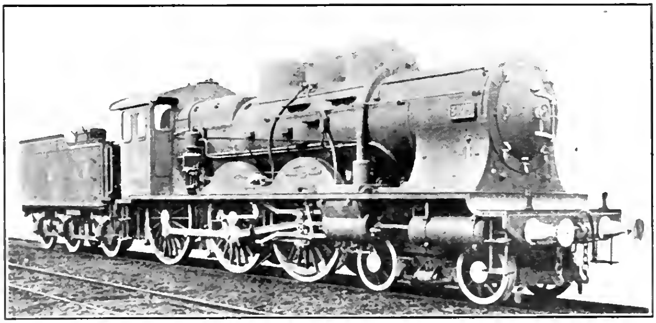
Great as was the work accomplished by the American railroads in the transportation of men and material during the war period, and its monumental effect in bringing to the Allied armies the sudden victory, it is well to remember that the French railroads accomplished a still greater task, and that, too, in the face of an advancing foe of such colossal proportions and such perfect organization that it is a marvel in transportation that the French were able to meet the emergency with that degree of efficiency that served to stem the tide of invasion until the Allies had gathered sufficient strength to drive back the invaders.

The war record of the French railways, upon which fell the colossal weight of backing up the French, British, Belgian, and, to some extent, the Italian armies, in stemming the Teutonic onslaught, receives full recognition in two articles by General de Lacroix of the French Army in the last two issues of the *Revue des Deux Mondes*. In a sober style, buttressed with eloquent statistics, the French General tells how those railways, handicapped by enormous losses of material through the German invasion and by the vast increase of demands on them for transportation of men, munitions, and food, nevertheless responded with superb patriotism and efficiency to the call of their country in peril, and, despite constant new tests and augmenting difficulties, "delivered the goods."

The supreme test of French railway efficiency began on the night of August 2, 1914, when the general mobilization of the French Army was ordered. At that hour the railways passed from civilian to military administration and everything was subordinated to the instant transportation of troops and material to northern France. The Paris-Lyon-Mediterranée system alone, one of the greatest in France, was obliged, for a period of 17 days, to provide over 3,000 trains. Between August 2 and 5 the great Orléans system handled 1,500 trains; and, from August 2 to 8, the Eastern railway system, in addition to getting the mobilized men within its territory to their destinations, had to transport 40,000 foreign workmen employed in the mines of Briey and Longwy who could not remain on the frontier exposed to the Germans.

The transportation of a French army corps at its full war strength requires, in addition to wagon convoys, an average of 80 trains (with a total of 4,000 cars). The huge mass of French troops whose instant transfer to their points of concentration was demanded at mobilization time consisted of forty-two corps. So tremendous did the glut of traffic finally become on the lines serving the north of France that, on August 9, 10, and 11, 1914, the Eastern company alone operated an average of 400 trains daily, the trains running on certain lines on less than four minutes headway and less than a mile and a quarter apart. And one must not forget, General de Lacroix points out, that even while handling these huge numbers of French troops, the French railways were also providing transportation for the British Army, which began to land in France on August 7. From the 12th to the 20th, 420 trains carried 260,000 British soldiers, with all the accompanying war material, inland from Boulogne and St. Nazaire without the slightest hitch.

During all this time of terrific stress, the French writer reminds the reader, the railways were working under the serious handicap caused by the capture of huge numbers of locomotives and cars by the



TYPE OF LOCOMOTIVE ON THE EASTERN RAILWAY OF FRANCE.

onrushing Germans. Losses from this cause at the beginning of hostilities reached a total of 55,000 locomotives and cars out of a total on the French railways of 13,800 locomotives and 376,000 cars. The net loss, however, was reduced to 45,000 by the acquisition of 7,000 Belgian cars and 3,000 captured German cars.

Hardly had the French railway men transported the great masses of French and British troops to the front when the disastrous battles at Mons-Charleroi and further east necessitated the great retreat toward Paris, in which the railways were again taxed to the uttermost. Besides carrying enormous numbers of men southward, they had to help in the transfer of army corps from one end of the line to points imperiled at the other, while the great operations incident to the battle of the Marne and the "race for the sea" were under way.

"This was certainly the most active period in the use of railway and auto truck transport," remarks General de Lacroix. "The French railways had to measure themselves in speed against the enemy, who could use the shorter interior lines for his war transport service."

Through 1915 the strain on the French railways continued, until, early in 1916, the railway situation reached a crisis when the Germans launched their terrific attack on Verdun. The enemy's advance directly menaced the railway through St. Menehould to Verdun, and the presence of the Germans at St. Mihiel cut off Verdun's communications in that direction. Finally, only one narrow-gauge railway between Revigny and Souilly was available for getting men and supplies into the beleaguered fortress. It was here that the auto truck came to the rescue, and, by its admirable services, saved the day.

For the Somme battles of the summer of 1916 the French railway authorities not only taxed existing lines to the utmost, but, by building many miles of narrow-gauge lines up to the very front—lines that were extended day by day as the British and French troops advanced—effectively contributed to driving the Germans from their strongholds and causing them to retreat the following spring.

In that spring a new emergency confronted the railways of France—the arrival of the Americans. They met it with their accustomed decision. During the first six months after America's entry into the war, says General de Lacroix, the Orléans railway system transported from St. Nazaire to points inland 12,000 American officers, 460,000 men, 22,000 horses, 200 wagons, and 25,000 tons of material.

On top of this came another and more serious emergency—the rout of the Italians at Caporetto—which necessitated the sending of big reinforcements of French and British troops from France to plug the gap and save Italy from the Austrian invaders. Says General de Lacroix:

"On October 23, 1917, the day when the enemy penetrated south of Plezzo, the

Paris-Lyon-Mediterranée railway company was asked by the military authorities to collect, within twenty-four hours, the crews and cars necessary to transport immediately beyond the Alps 120,000 British and French troops, with all their artillery and material. This prodigy was accomplished. Less than twenty-four hours after the receipt of the order, 500 locomotives and 12,000 cars departed from points all over the network of the company's lines toward the zone of embarkation of the troops. One day later the assembled trains were ready.

"On the 28th, the 12,000 cars started and, for four days, stretched between the French front and the Trentino. On November 8 the Italians, having carried out their retreat, were enabled to stop in complete safety on the Piave, assured of French and British reinforcements."

Throughout 1917 and 1918 the French railways kept up their admirable war work, despite all handicaps, contributing toward the success of the retreat before the German offensive of 1918 and toward Foch's lightning blows of last summer which ended the war. Now, finally, their strain is over, they can try to patch themselves up and get back to a normal basis, and men like General de Lacroix can figure up just what that strain has been from one end of the war to the other. Here are some of the figures compiled by him, taken at random from his articles:

The Orléans system alone carried, in 1915, a total of 3,700,000 officers and men; in 1916, 5,827,528; in 1917, over 8,000,000.

The "regulating stations" of the French railway systems, which became the great distributing centers of the trains destined to keep the front supplied with men and material, were each organized on the basis of supplying daily, for each army of 500,000 men, the following:

Ten provision trains.

Five trains of artillery munitions.

Two trains of engineering material.

One train with miscellaneous supplies.

Two trains with stones for repairing roads.

Three trains for reinforcements.

In other words, a total of 23 trains per "regulating station." All told, the French armies required 200 trains a day, which, allowing for rolling stock withdrawn for repairs, meant 550 locomotives and 30,000 cars.

Each French division in battle required, at the end of each day and within easy distance, 1,000 tons of supplies. To supply all the French fighting forces, it was sometimes necessary to provide 100,000 tons daily.

To fill up vacancies caused by the drafting of railway employees for the army, the French railway companies finally resorted largely to the employment of women, until, in 1917, they had a total of 32,000 women employees. The percentage of these ran from 11 to 20 of the total number of employees, whereas in England it never passed 5 per cent.

Despite the constant building of new rolling stock, the total of French, English, Belgian, and American railway stock in France on September 17, 1918, at the height of the strain on the French railways, was 6 per cent less in locomotives and 9 per cent less in cars than the peace total, according to a statement made in the French Chamber of Deputies.

During the war 7,000 kilometers of new standard-gauge railways (about 4,375 miles) were built in France, an average of 150 kilometers (about 93 miles) per month.

In 1914 France had 1,400 kilometers (about 875 miles) of narrow-gauge (60 centimeter) lines, with 60 locomotives and 350 cars. In 1918 the length of these lines was 4,000 kilometers (about 2,500 miles) and they employed 900 locomotives or tractors and 4,500 cars. Many locomotives had been replaced by tractors using gasoline.

In 1918 the construction of narrow-gauge lines had reached such a point of efficiency that they followed the advancing armies at the rate of 1,500 to 2,000 meters daily (about 1¼ miles).

General de Lacroix points out that the German wail about the armistice clause requiring the delivery of 5,000 locomotives, 150,000 cars and 5,000 auto trucks is unjustified in view of the fact that Germany increased her rolling stock during the war by the following totals of captured cars: Belgian, 80,000; French, 25,000; Russian, 70,000; Serbian, 12,000—a total of 187,000.

An efficient type of the locomotives in service in the early days of the war on the Eastern railway of France is shown in an illustration, and also reference to the Pechot locomotive for narrow-gauge service, several hundreds of which were built by the Baldwin Locomotive Works for the French Government. The general dimensions of the French compound passenger locomotive are as follows: Cylinders, high pressure, 14¼ ins. by 26¾ ins.; low pressure, 23¼ ins. by 26¾ ins. Diameter of truck wheels, 36¼ ins. Diameter of driving wheels, 6 ft. 10¼ ins. Boiler pressure, 227 lbs. per sq. in. Heating surface: Firebox, 175 sq. ft.; tubes, 2,354 sq. ft.; total, 2,529 sq. ft. Grate area, 33 sq. ft. Capacity of tender, 4,817 gals. Coal, 7¾ tons. Wheelbase, engine, 29 ft. 2 ins. Tender, 14 ft. 9½ ins.; total, 53 ft. 7⅞ ins. Length over buffers, 38 ft. 8¼ ins.; tender, 25 ft. ½ in. Weight in working order: engine, 75 tons, 11 cwt., 3 qrs.; tender, 49 tons, 15 cwt.; total, 125 tons, 6 cwt. 3 qrs.

In regard to the Pechot locomotives it might be stated that the total length of the locomotives is 7 ft. 6½ ins. and the gauge of the track for the locomotives as adopted is 23⅝ ins. The engines have two boilers.

Fuel Inspection.

At a recent meeting of the Cincinnati Railway Club, Hon. D. E. Dick, Fuel Inspector of the Baltimore & Ohio railroad, gave a graphic account of his experiences, from which we extract the following: "I have been through all sorts of fire in the political game in years gone by, but the worst fire I ever encountered came from coal operators, because of my having rejected their coal. I had one operator out in Illinois tell me that I was the most bull-headed, block-headed, thick-skulled individual he ever met in all his life, and this because I was trying to convince him that sulphur rock from an inch to two inches in thickness was bad foreign matter and should be kept out of our railroad coal. He contended that it had a right to go with the run of mine coal, that run of mine coal meant everything in the vein, clay, slate, bone, sulphur and sulphur rock. The more I argued with him the more contrary he became. Finally, he said, 'I'll get you!' This was another thing we had to deal with, to a very great extent in those days, hardly ever at the present time. Coal operators would use every lever they could pull, political and otherwise, to endeavor to discredit the official that did his duty and tried to make them live up to their contracts. This fellow said he would get me very shortly, and talked as though he was confident of his ability to do so.

"I very frankly told him that if the B. & O. railroad didn't want this coal inspected and properly prepared, they would hardly go to the expense of sending me through that territory for inspection purposes. I quite emphatically said to him that if the railroad sent me out there to be a figure-head in the hands of the coal operators, they had sent the wrong individual, that I may not be here over twenty-four hours, but that I would be the Fuel Inspector while I was there, and would not pass favorably upon any coal that did not come up to the specifications and instructions given me by our Engineer of Tests; that I would not be intimidated, influenced or coerced by any power whatsoever, that I would do my duty, and that he could fire away, go ahead and do his worst.

"He wrote to the Baltimore office one of the meanest letters I have ever seen. He was not content with saying my inspections were unfair and drastic, but he said my language was vicious in its character. He did not say that I cussed, but that is what he meant to say, and if I didn't cuss it wasn't because I didn't have ample provocation through the presence of bad foreign matter in that coal. In less than a week, fortunately for me and our inspection system, and unfortunately for him, that letter was sent to me, with instructions to continue carrying out our policy of inspection.

"I happened to be in Illinois at the time, and that was where this mine was located. I went to their main office, and called on this mining official and said to him, 'I am still on the job.' He pretended not to understand my meaning, so I said, 'That letter you sent to Baltimore apparently didn't accomplish the purpose intended.' He asked, 'What letter?' and then I pulled his letter out of my pocket and showed it to him, and if you have ever seen a sudden change come over a man's face, you can realize what came over his at that particular moment. In an instant it dawned on him that the railroad coal inspection system was no longer a pretense, but a stern reality, and that the coal from his mine and all other mines, for railroad use, had to be given proper preparation.

"Not only in this case, but in other instances, I found that it was the practice of coal companies to bring every influence possible to bear against a railroad official who tried to do his honest duty towards seeing that the contracts were complied with and the interests of the railroad fully protected.

"I had quite a number of operators tell me that I did not know my business when I rejected their coal, notwithstanding the fact that I went through every phase and experience of a coal miner's life. On one occasion, when talking with the president of a certain company about coal that had been rejected from his mine, he evidenced a feeling of intense hostility, and with emphasis reminded me of the fact that one of his closest friends, personally, was a leading official of the railroad for which I worked as Fuel Inspector. I told him that was immaterial to me, that it mattered not who his friend was, that could have no reasonable application to the case being discussed. I told him with emphasis, I did not care if he was the right-hand bower of the King of Kings, that that had nothing to do with the merits or demerits of the coal they were furnishing the Baltimore & Ohio railroad."

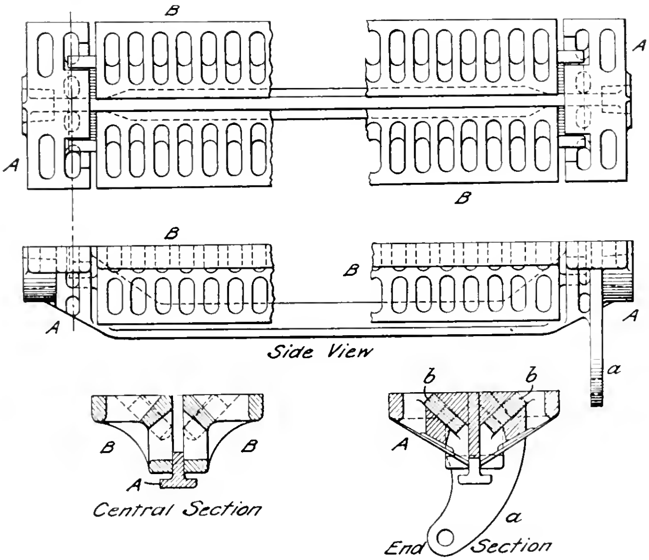
New Design of Grate Bar

The new grate bar which is shown in the accompanying plan and side views, and end and central sections, has been designed for the purpose of materially reducing the extent and expense of foundry construction, due to renewals of partially burned bars, which constitutes a large item of expense in locomotive maintenance. This object is accomplished by making the bars of such form that when their fuel supporting surfaces are burned, in any part, to such an extent as would, if they were of any of the present patterns, render them unfit for further service, they may be turned to present an entirely new and unused surface, thus correspondingly lengthening their life.

As shown, the design comprises a carrying member or cradle, A, which is supported on bearers, in the ordinary manner, and may be rocked therein, by connection to a downwardly extending arm, *a*; and two fuel supporting members, or bars proper, B, the ends of which are fitted detachably in the cradle. As will be seen from the central section, these bars are counterparts, and are of inverted L form, each of the legs or sides of the L having transverse air passages throughout its length; each of the sides being thus adapted to act as a fuel supporting surface, either in the manner of a table or a finger grate. As shown in the end section, the bars are attached to the cradle by inclined tongues, *b*, near their ends, which fit in corresponding slots in the cradle, this means of connection allowing them to be readily inserted and removed, as the occasion may require.

When the upper leg of a bar, on which leg the fuel is supported, becomes so much burned in any part as to make this leg unfit for service, the bar is detached from the cradle, turned one-quarter around, and replaced in the cradle, the other leg, which has not previously been exposed to the fire, then presenting a new and unused surface for supporting the fuel. The readiness with which this change of position can be made, and the increase of service life which it gives to the bar, will be obvious.

The designer, Mr. Robert C. Morton, who is connected with the Mechanical Department of the Baltimore & Ohio railroad, has made application for a patent for the improvement and there is every likelihood of its being received with much popular favor.



DETAILS OF NEW DESIGN OF GRATE BAR.

The Scrap Heap.

The scrap heap is a kind of a shop barometer telling in its own mute way of the general shop management and of the use or misuse of materials. A scrap heap represents "employed capital," and at present when all railroad materials have advanced enormously in price the employment of this capital should be along business lines so as to produce available assets. Valuable lessons can be learned by an intelligent inspection of various pieces which are common to a scrap heap. The undue weakness of component parts of locomotives, cars and machinery is shown by their presence on the scrap heap; and a careful inspection of the appearance of the breaks will show where the parts need strengthening.

Tapping Hard Metal.

It is a common occurrence for a tap to break when tapping hard metal. If the tap is ground away on the point, so that the first five or six threads will be gradually bevelled, the risk of breakage may be largely avoided. The effect of grinding the end of the tap is to break up the chips into smaller pieces and thus prevent clogging the threads of the tap. This will be found to be especially advantageous in tapping very hard rolled steel.

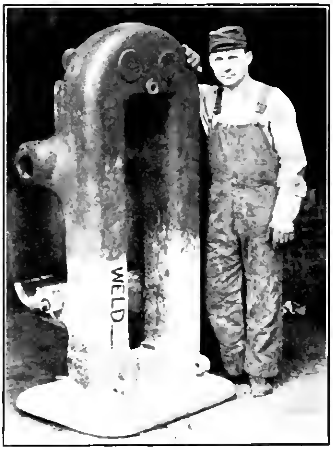
The Welding of Steel Castings

By J. F. Springer

Cast steel has been coming into considerable use during recent years, largely because of its great strength and high resistance to heat. By cast steel is meant steel which has been cast in a mold. One is to distinguish from forgings made from a steel ingot. Naturally, an ingot is a casting; but it does not follow that a forging or other product formed by working the ingot steel is also a casting. "Today we buy many tools and implements which bear the name of cast steel, which we know to have been forged in bringing them into their final shape. But it is not these which we mean by the term cast steel, but rather those steel products which get their final form by being 'cast' from a fluid condition into a mold. These are what are rapidly coming to be understood when the term 'cast steel' is used." "High carbon open-hearth and Bessemer steel merchant bars, tool blanks, etc., sometimes masquerade as 'crucible steel,' or, perhaps, 'cast steel,' which is the trade name for crucible steel; other deceptions are not unknown; indeed, even malleable cast iron is sold oftentimes as 'steel castings.'" "In the form of small castings, malleable cast iron and similar products often masquerade under the name of steel, because under that name the producer finds a readier market for them. On account of their fluidity, they may be cast very cheaply in small size, and therefore the temptation to use them as material for 'cast-steel hammers,' is a strong one."

I have quoted the foregoing extracts from L. W. Spring and Prof. Bradley Stoughton. They will serve, perhaps, to put us on our guard. The present article proposes to deal in part with the subject of welding steel castings. The term is understood to mean exactly what its words import—castings made from steel. The directions for welding steel castings herein given are, accordingly, to be understood as applying strictly to the material implied and not to the substitute for it, such as malleable cast iron.

Steel castings will ordinarily be made from steel that contains a good deal of silicon. The parent steel for the casting may be crucible, open-hearth or Bessemer steel. All contain more or less manganese. With regard to the latter two steels, it is necessary, if the founder would avoid serious danger from blow holes, to keep either the manganese or the silicon in rather high amount. Sometimes the silicon goes up as high as 0.6 per cent. This is much more than steel ordinarily contains. The purpose is, as said, to avoid the creation of blow holes. Crucible steel contain a smaller percentage of silicon, although, even with it, the amount of silicon may be fairly considerable. In short, then, when one has to do with steel castings, he has to do also with silicon. This substance is a chemical element which melts at about 2,588 degrees F., which is somewhat lower than the melting point of low carbon steel. But, it is not so much with its melting point that one has to reckon in welding with the oxy-acetylene flame. The "hot spot" is understood to have a temperature of some 5,500 degrees. It should not surprise us then, perhaps, if silicon is vaporized when the "hot spot" is brought to bear upon cast steel. I do not know the exact temperature at which silicon vaporizes. The *Smithsonian Physical Tables* omit silicon from the list where the information would be found. One may, however, consider it as fairly certain that, when one has to weld work consisting of cast steel, more or less silicon will vaporize and be lost. This is perhaps not as important as the consideration that silicon must certainly be lost from the new material put into the groove to make the weld.



VIEW OF HEAVY STEEL CASTING AFTER WELDING.

It is to be reckoned good practice to use the same material to fill the groove as that which is in the work. One writer suggests that in cutting out material to form the groove the pieces be saved for use in the welding operation. Nay, he even suggests that at times surplus metal might be cut off from other parts of the work. Another writer suggests that "small cast bars of the same metal" as that in the work be employed. However, pure iron (such as Swedish soft iron) may be used as filling material, and so also may cast iron. Further, the pure iron may be used along with the cast bars or along with the bits of material gotten from the casting itself. It appears, at first sight, as if one had quite a choice. Let us consider this point.

Steel castings are naturally employed, in part, because of the strength of the material. If a groove is made and then filled in with soft iron or cast iron, strength will to some extent be lost. The conditions may be such that this loss will be of no importance. On the other hand, the conditions may require the full strength or a fair approximation to it at and near the joint. The workman must see to this point of strength before going ahead to fill in the groove with soft iron or ordinary cast iron. Sometimes, the situation is such that the new metal may very well be piled on and the region of the joint given its proper power of resistance, not because the metal is just as strong per square inch of section, but because there is plenty of it. There are occasions where this rather crude method of insuring the strength is inadmissable.

By using precisely the same material in the filling as that which is in the work itself there is reason for expecting strength not so far different from that of the work, unless the welding operation has some damaging effect. Silicon tends to produce soundness in a casting, and this is regarded as probably a large reason for the beneficial effect observed. "In the case of castings, however, an important increase in tensile strength may be obtained by increasing the silicon to 0.3 or 0.4 per cent. This practice results in practically no decrease in ductility." Now the filling that is put into a groove is really a casting. The thing which one had to fear is that the high temperature of the "hot spot" and its vicinity may vaporize out a good deal of silicon, with the result that the filling is not as sound and strong as it should be. Apparently, then, the thing to do is to provide cast rods containing more silicon than is really wanted, the object being to have enough to stand the loss. Probably the next best thing to do is to use the same material as that in the work.

Another matter in connection with steel castings relates to the difficulty sometimes experienced, especially if the percentage of carbon in the casting is high, in making the weld at all. It has been suggested, and I pass the suggestion along, to add a little melted copper to the weld. This "will cause the metal to flow and a fairly good weld can be made." On the other hand, the effect of the copper should be

considered beforehand—"copper is likely to harden the metal so that it cannot be machined except by grinding."

RESTORATION OF THE STEEL

When a steel casting is welded by filling in with steel, one has a chance to restore quality to a greater or less extent insofar as the damage may have arisen from the effects of the high temperatures upon the grain structure. That is, one may indeed treat the whole casting. I do not propose at this moment to go into the whole subject of the restoration of steel in general. There would scarcely be space for the purpose in the present article. Later on, perhaps. At the same time, I can give a workable account of what may be done in the present case where steel castings are concerned.

Research has disclosed the fact that steel suffers in strength whenever it is heated from a normal condition of maximum quality up to points beyond a medium cherry red. The higher the heat goes, the greater the damage. Cooling off is no real remedy, whether the cooling is done rapidly or slowly. But if, after cooling, the steel is heated up again to a point which varies with the character of the steel, especially with the carbon percentage, then the steel will be improved In some cases, the restoration will be very considerable, and may even approach complete restoration. In others, the restoration is partial. This is especially the case with low carbon steels.

Now it is approved practice when originally making high-grade steel castings to give the casting this re-heating treatment. It is done for two purposes. One is to break up or equalize strains produced in the casting by the process of manufacture; the other is to restore the quality lost by the heating up beyond the medium cherry red when the metal was heated for the purpose of making the casting.

With respect to the small casting molded in the groove when the welder filled in with steel in carrying out the welding operation with respect to this small casting, one may apply the same procedure found serviceable in making high-grade steel castings. That is, the region of the weld, all the metal that has been heated beyond a medium cherry red is heated up to the right point and then allowed to cool off. This is an annealing procedure.

There can be no doubt of its excellence as a remedy. When one has properly applied it, he has done about the best thing that can be done. The question is, how to carry out the method. Undoubtedly, it will generally be best to treat the whole casting, weld and all. Then difficulties are avoided and matters made simple at one stroke.

If the casting and the steel in the weld have a low-carbon percentage, say, 0.20 per cent. or less, then the annealing temperature will need to be rather high, say, 1,650 degrees F. This is the temperature indicated by orange. It is the color which occurs just after light red is passed. That is, red is now no longer alone, but is mixed with a little yellow. It is undesirable to go higher than what is really necessary. For this reason, a light orange is to be avoided. The color wanted is a red containing only a minimum of yellow.

If the steel in the casting and in the groove contains more than 0.20 per cent. of carbon, the temperature requirement may be relaxed a little and only a very light red required.

What must be borne in mind in re-heating the casting for the purpose of restoring quality to the weld and to adjacent portions of the casting is that only those portions of the metal actually participating in the annealing heat get the full benefit. Deep down, out of sight, may be regions that do not obtain the full heat. The fact that the outside of a piece of metal is a very light red or an orange does not necessarily mean that the inside has reached the same color. If the final point of the heating is done gradually, especially when the work is thick, there is more probability that the interior is but little cooler than the outside.

Increase in Wages.

The further increase in the wages of a limited number of railroad employees has raised much unreasonable discussion among certain classes both of the press and public, some of whom seem to forget, or perhaps they do not know, that for many weary years these classes of men have been shamefully underpaid, that is in comparison with those in other occupations. At the close of the Civil War the average wages of skilled mechanics in railroad shops was $2.75 per day of ten hours. During the succeeding thirty or more years the wages had diminished to $2.60. A slight increase occured in certain sections before the beginning of the great war, and while almost every other class of workmen had their wages increased there was no particular hurry about adding to the remuneration of the railway employees. They were used to it. Now when they are coming into something like reasonable wages, a cry goes up as if red ruin was upon us. Those who never got fair treatment before are now coming into their own. In our opinion it was high time. A reduction will likely come as we approach normal peace conditions, but it should begin in the cost of living. Our would-be saviors of the country should give their attention to that large class of middlemen that live and move and have their unproductive being between the producers and the consumers.

A New, Quick Way of Opening Storage Batteries.

Removing cell plates from batteries has always been a great problem for the charging stations, because of the difficulty in getting the plates out without injury to the batteries and the time consumed for the work.

There is now a new, compact, strongly built device marketed, which does away entirely with the time and labor trouble formerly experienced. Plates of a three or six-cell battery are removed in 5½ minutes. The most stubborn cases yield readily to the new method. Compare this with the old steam box system, averaging from 25 minutes to one hour, oftentimes not working at all.

The new apparatus has a steam generator with six jets, three of which are controlled by a valve. The valve is closed for three-cells batteries and opened when all six jets are used. Time required to get up sufficient steam is from 2 to 4 minutes.

The steam generator is fitted with a safety pop valve which blows off pressure at ten pounds. However, the manufacturers claim pressure is never above three pounds. The process of softening the sealing compound is exceptionally simple. The vent caps of the battery are removed and the jets inserted on each cell. Steam is forced direct into cells. Within four or five minutes the plates are removed. Cost of operation is 3 cents. Grease and other impurities can be steamed and cleaned off the batteries also.

The outfit is operated by kerosene, although when desired gas burners can be furnished. A one-gallon capacity melting kettle for melting wax for resealing, a 35-lb. capacity lead melting pot for reclaiming lead, and a lead mould to make lead sticks, are furnished with the apparatus, which is manufactured by the Hauck Manufacturing Company, of Brooklyn, N. Y.

Sticking Gaskets.

Where asbestos and some other materials are utilized for gaskets, they are apt to stick to the metal and upon overhauling must be scraped off. This means making new members and a loss of time and a source of expense. A tight fit may be made by rubbing the packing and metal parts with dry graphite, which is not affected by heat and will allow the gaskets to be removed as a whole.

Chalk Your File.

If a little chalk is rubbed on a file before filing steel, it will keep the chips from sticking in the cuts in the file and prevent scratching the work.

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Solving the Railroad Problem.

The work of the early pioneers in railroad construction has been of such a monumental kind in the development of the country that in itself it ought to be a repudiation of those who desire to establish men, untried, and as far as has been shown, unsuccessful methods of carrying on some of the vast enterprises upon which the welfare of the people so largely depends.

This view was forcibly maintained by Howard Elliott, president and chairman of the Executive Committee of the Northern Pacific Railway Company, in an address to the Chicago Commercial Club last month. He believes that Government ownership, management and operation of American railroads are not for the best interests of the nation, and that private ownership, with wise, energetic and honest management and operation under reasonable and protective regulation, will produce the best results for the country. This regulation should be so arranged and directed to preserve and encourage the initiative of the American citizen, to be prompt and responsive to changed conditions, but, at the same time, provide checks to prevent any unfair practices to owners and managers, and also to prevent repressive, unreasonable and conflicting action by regulatory bodies.

It will be generally admitted that of all the qualities that have co-operated to develop the American railroads to the commanding position that they now occupy, the most impressive is a great and tireless energy. The first care of the American people should be to maintain this monumental spirit in all its integrity. The essential condition to the development of energy is liberty. Every restriction on liberty, with however good purposes, diminishes the individual responsibility and initiative. Yet measures are introduced which, under the pretext of correcting abuses, are calculated to extend the Government's field of action, and reduce the liberty of the citizens. We should reject such enervating proposals, and remain true to the virile and liberal traditions that have produced so wonderful a growth.

It is also admitted that it is necessary to change and modify some practices and ideas that have long prevailed. The owners must consent to Federal control, but they should also have Federal protection and encouragement. The labor organizations must assent to some mutually co-operative way of settling disagreements over wages and working conditions, so that the railroads will continue to serve the public pending the adjustment of inevitable disputes. The Government must be more responsive to changed conditions, and there must be protection of this great industry as well as regulation, and there must be no disputed zone between national and State authority.

The railway executives, all of whom are men of wide experience, and have been brought up in a hard school, have made the following suggestions: Ownership, management and operation should be by private owners rather than by the Government. Regulation as to all essential matters, including rates, both State and inter-state, to be by the Federal Government, which shall control in case of conflict with States. The establishment of a Department of Transportation with a Secretary, who shall be a member of the President's cabinet. The prohibition of lock-outs and strikes until investigation and report, so that public opinion can have a chance to express itself. Provision for an impartial board made up of an equal number of representatives of the public, of the employers and of the employes, to report to the Secretary of Transportation upon the merits of the controversy which the parties are unable to adjust. Also the arrangement of a unification of the roads into a continental system in a national emergency such as war.

Certain it is that private ownership and operation, while not perfect, have produced unusual results. It furnished better service to the public and at lower rates, and had paid the highest wages to employes than in any other country. It is a mistake to imagine that there was an general breakdown of the railroad system at the time that America was drawn into the great war any more than the inability of the steel companies to furnish all the steel required, the cotton mills all the cotton wanted, and the shipyards all the ships wanted, was a breakdown of these industries. In these cases immediate steps were taken to increase capacity, most of which steps are not even completed now. The real trouble with the railroads was that under the existing regulatory system not enough latitude had been given to the railroad business to permit it to keep its plant ahead of the demands of the country. At the present time the failure of Congress to pass the necessary appropriation bill for the maintenance bill has created added difficulties, but it is to be hoped that a way will speedily be found to save the situation until the incoming Congress can act. It is not unnatural to expect that the Interstate Commerce Commission, established over thirty years ago, that some defects have been developed in a plan created out of the thought and opinion of that time, and that it has been found lacking under the conditions of today, and it is fortunate that many suggestions about the important subject are now being made, and we are assured that as the subject is being approached calmly and deliberately, the needed wisdom will come to us that has guided us through other difficult problems that for a time at least seemed insurmountable in their magnitude, and multiplex in their details.

Electric Versus Steam Locomotives.

In the course of an interesting paper by Calvert Townley on the subject of "Some Possibilities in Steam Railroad Electrification as Affecting Future Policies," it is stated that "electrification has also been retarded because the problem has been largely considered one of replacing the steam locomotive by the electric locomotive, whereas in reality the problem is much broader. It really offers a fundamentally different method of train propulsion because the limitations of the steam locomotive disappear and the strictly limited motive power is replaced by one that is practically unlimited, thereby opening up many possibilities in the methods of railroad operation. While there are a number of different systems of electric traction all of the systems have many features in common and the possibility of unlimited electric power is a characteristic of them all. A brief review is given of electrified sections of railways showing the advantages which have been realized in both the freight and passenger service. Existing electrifications have been operated for a sufficient length of time so that operating statistics are now available, and any proposed undertaking may therefore be predicated on established facts. While electrification

will greatly increase track capacity, there is a large railroad mileage which already has more than sufficient capacity, in which case electrification would not be justified. On the other hand, there are so many cases where its advantages are clear and conclusive that when the railroads are able to finance their required electrification it will test the capacity of the electric factories of the country to serve them."

Generally speaking, a steam locomotive is in prime condition when new or after a general overhauling and suffers a progressive reduction in capacity until sent to the shop for general overhaul. On the other hand, with electric locomotives there is no diminution in capacity dependent upon the condition of the locomotive.

Along with its increase in size, a steam locomotive has developed far greater complication as a machine and with very large locomotives especially, the time out of service reaches a high percentage. The difficulty and expense of maintenance are also very greatly increased. This has proven to be a very great burden for the upkeep and maintenance of steam locomotives owing to the shortage of labor and particularly of skilled mechanics. The maintenance of electric locomotives, on the other hand, is accomplished with a surprisingly small amount of attention and expense; in fact, the repairs and renewal of the purely electrical equipment are almost insignificant if the apparatus is properly proportioned to the work and its performance has been restricted to the limitations of its design.

The cost of maintenance of electrical equipment is, therefore, very largely determined by the history of its operation. This limitation does not obtain in any such corresponding degree with steam locomotives and in view of the newness of railroad electrification has not been given universal consideration in the service expected of electrical equipment. This, therefore, is a great reason for the disparity which exists in such figures as have developed upon maintenance costs of electric locomotives. However, with the growing appreciation of this condition, we may look in the future to low records for cost of maintenance of electric locomotives generally equaling and even surpassing those which have been made in certain installations up to the present. Thus, it may be assumed that the saving in maintenance of electric locomotives which is generally taken to be around 50 per cent, will be materially increased as an average condition in the future.

The method for general railway electrification is now universally accepted on this continent to be an overhead working conductor at high voltage. This is due to our method of working the railways, influenced, of course, by the conditions existing as to location of tracks, stations, yard working, etc., obtaining on this continent. There has been distinct advance in the character of overhead construction and there is promise of still further improvement, all in the direction of a more satisfactory working conductor at lower first cost. This is manifestly important as affecting the investment, since the mileage of track, including that in yards, is enormous.

In these days of increased costs, that for the supply of electric power is almost alone in having been stationary or even reduced during recent years. This has been due to the economies obtained by the generation and distribution of large amounts of power.

The transportation problem is unquestionably one of our major problems of the present. We now realize better than ever before the value of planning for our future and this applies with great force to transportation. For its relief, railroad electrification should be one of the most important factors. The problem is a large one, and for its solution, engineering skill and breadth of vision of the highest order should be applied.

The Air Brake Convention.

By the time that the May issue of Railway and Locomotive Engineering reaches the hands of the bulk of our readers the Annual Convention of the Air Brake Association will be in session. It will be borne in mind that while the other mechanical associations had suspended their annual conventions during the war period, the Air Brake Association was deemed of sufficient importance to be continued. That the admirable work done at the conventions of the association has fully justified the course pursued will be universally admitted. The added knowledge that has been gained by these meetings and its application to the difficult problem of transportation has had an important effect in the moving of men and material at a time when the fate of civilization hung in the balance, and every minute was of unparalleled value is known to all right thinking men. It would be idle to decry the work of the other associations. Much of real value may have been missed, but the absolute necessity of the master minds staying at their posts was deemed of more importance than meeting to discuss minor details. Much is expected of all of the conventions this year, and we are confident that in no instance will there be cause for disappointment.

The German Locomotives.

As described in the first pages of the present issue of Railway and Locomotive Engineering the German engineers have been walking in the valley of humiliation for the last two or three months in passing over a large portion of their railway rolling stock to the hands of the victorious Allies. It is peculiarly gratifying to note that the American engineers have been selected to pass upon the condition of the transferred material, and is a high compliment to the efficiency of the American railway men. The operation has taken much longer time and is of less spectacular appearance than the surrender of the German battle fleet, and the feeling may be less keen among the German railroad magnates than among the commanders of the ships of war

Be this as it may, it is certain that there will be no dissension among the allies as to the use to which the reclaimed locomotives and cars will be put. There has been talk of sinking the German fleet, but there will be no suggestion of scrapping the German motive power and rolling stock. After being passed upon by the experienced American engineers, it will be put to good service in the rejuvenated fields of Flanders and valleys of a regenerated France.

Of another thing we are certain, that there is safety in the bankruptcy of German courage, but little cause for rejoicing on the part of any people who respect the decencies of our common human nature.

BOOK REVIEWS

Earning Power of Railroads. Compiled and Edited by F. W. Mundy. Published by Jas. H. Oliphant & Co., 61 Broadway, New York.

The official annual reports of railroads have been used in the preparation of this book, and will readily commend itself to investors and others interested in the securities of railroads. Explanations are given in a general way of the fundamental principles which must be applied by the investor as to the value of the stocks or bonds of any railroad. The work embraces all of the important railroads in the United States and Canada.

Trautwine: The Civil Engineer's Pocket-Book. By John C. Trautwine. Revised and Enlarged 20th Edition. Trautwine Company, 257 South Fourth street, Philadelphia, Pa.

A new edition of this standard work, revised and enlarged, is now ready, and an advance copy of the extensive additions is before us. The work needs no praise at our hands. It is universally recognized as in the fore front of railroad engineering publications. The present edition retains all of the fine features of the earlier editions, and such new matter as recent improvements call for. About 400 new pages are added, and, as formerly, all new work and all revisions can be readily understood by any one who understands the use of common decimal fractions. In the matter relating to turnouts and crossings, and curves on railroads, the additions are of great value.

Physical Tests of a New Tool Steel

Details of Tests and Analysis of Its Structure

During recent years, many improvements and developments have been made in all forms of tool steel. Alloy steels have been highly improved and developed, superseding as they do in some measure but by no means totally, the time-honored carbon steel. High speed steel is a recent development and everyone is aware of the improved efficiency that can be obtained in machine shops by the use of this steel. The metallurgist is constantly seeking for something new in cutting tools and hardly a month goes by without some slight improvement being effected in this class of tool steel, but the time-honored chisel steel has lain by the wayside and has not been developed to an appreciable extent.

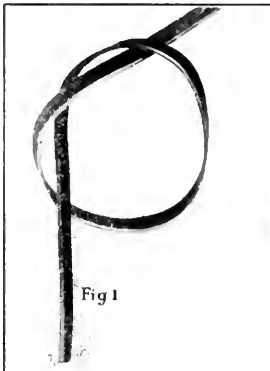


Fig 1

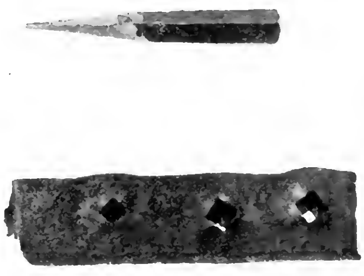


Fig 2

Chrome and chrome-vanadium as alloys have been added to the chisel steel melts and have improved this class of material, but the type of blow coming upon a chisel has not been studied sufficiently and even more important than this, the way in which the chisel steel is forged and heat-treated.

A new steel has just been developed which has a number of unusual properties. It has been customary to imagine that a steel that is hard must be of necessity brittle and, although this is true in nearly every instance, yet this new steel is a paradox and a contradiction to this contention.

Many disappointing results are being obtained from the use of alloy steels. This is largely due to the fact that every alloy has a certain critical analysis. Every combination of alloys has a certain high-water mark or peak where the best results may be obtained. It does not necessarily follow that because chromium gives very good results as an alloy that 2 per cent should be twice as good as 1 per cent, and this is particularly true where the stress upon the tool is largely dynamic rather that static.

After a large number of very discouraging and unpromising results, the Ludlum Steel Company were able to so alloy various elements to get a combined peak efficiency with the result that there has now been produced an alloy chisel steel which can be made so hard that it will cut glass, yet this steel may be bent by being hammered over the edge of an anvil; and even then not too much care exercised. It would be naturally thought that such a steel would be very prone to shades of differences in heat-treatment, yet again it is not so.

This steel is almost fool-proof in hardening. It has a very wide temperature range; as a matter of fact this steel may be heated anywhere between 1650 degrees F. and 1950 degrees F., yet excellent results may be obtained. The maximum efficiency, however, is effected by the heat-treatment and the steel seems to have its greatest efficiency when heated to 1750 to 1800 degrees F., quenched in oil and slightly drawn. The drawing does not seem to affect the hardness of the steel but it assists the toughness.

Many guesses can be made and theories evolved as to just why this slight drawing is of such assistance to this steel, but metallographically there is no evidence of difference between straight hardening and hardening and drawing. As a matter of fact, the same structure can be produced as seen under the microscope, yet there is a great deal of difference between the two heat-treatments.

This new "Seminole" steel was developed by Mr. P. A. E. Armstrong, vice-president of the Ludlum Steel Co., Watervliet, New York, and is particularly recommended by its makers for bridge building and railroad shops, especially for pneumatic chisels, beading tools, rivet snaps, etc., as it will not break under the head or at the fillet. As illustrating the merits of this new steel, Fig. 1 shows the unusual things that can be done with this steel. Particular attention is drawn to the sample which is a piece of $\frac{1}{4}$-in wide x 1/16-in. that is almost file hard, yet has been tied in a knot. The loop is about $1\frac{3}{8}$ in. diameter. This sample has perhaps nothing at all to do with a chisel, yet does demonstrate the tremendous toughness and the unusual properties present. Fig. 2 is a 5/16 in. square piece, drawn down to a fine point, 1/32 in. square at the point, driven through a piece of low carbon steel three times without the spike breaking.

Other spikes have been ground so that they would cause the spike to bend or curl up as it went through the low carbon steel. Fig. 3 is an actual instance where the spike has curled round as it passed through the bar, yet the spike was not broken.

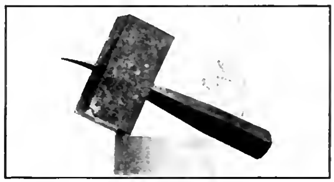


FIG. 3.

Fig. 4 shows a chisel that has been driven through .35 carbon steel, bent over, then taken to the anvil, the edge straightened out, and bent again. This operation was performed two or three times, yet the chisel was not broken.

Fig. 5 shows a billet in which a $\frac{1}{2}$-in. square spike has been driven through the billet, yet the spike is unbroken. Fig. 6 shows a chisel driven through a 7-in. x $2\frac{1}{2}$-in. square .35 carbon steel slab without bending or damage to the edge.

Two chisels of $\frac{7}{8}$-in. octagon steel were

FIG. 4.

made up in one large railroad shop and the chisel after being tested by the usual hand operations, was held in a pair of tongs and tested on a piece of 4-in. x 2-in. smith tool chisel steel about 75 to 85 carbon. Two husky hammermen were requisitioned to do their best to drive

some large chips off this piece of tool steel, and incidentally break the chisel. After a few hours of work, the hammermen were desirous of a rest but the chisels still remained unbroken and to all intents and purposes were as good as when they first started.

One of the things that appealed to the superintendent, as much as the cutting efficiency of the steel, was the unusual property of the head of the chisel not slivering. This brings another important point before the minds of everyone. The head of this peculiar chisel steel can be heat-

FIG. 5.

treated so that it is readily fileable, in fact quite as soft as the usual carbon steel, yet it will not break out or crack. It will spread but it will not split, yet the surface of the head does not take on a very glassy surface and seems to have a grip on the hammer-face when it is struck.

Metallographically this new steel is very peculiar. It seems to have a remarkably fine structure which is quite difficult to define in the usual nomenclature of the metallographist. It may be solid solution

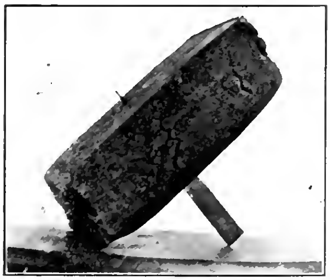


FIG. 6.

which is generally regarded as Austenite, or it may be Martensite. It seems under the microscope to have an appearance at lower magnification of the whole range of solid solution steel, yet it has the characteristics of none. Under high magnifications of 1200 X, the structure appears to be somewhat like Martensite, yet the Martensite appears to be lamellar rather than the usual 60 degrees marking.

The grain boundaries, which are particularly tenacious in this steel, have the coloring effect of Troostite, yet they do not have the usual Troostite formation. As we all know, Troostite begins to form in round spots at the grain boundaries. This constituent in the new steel does not take on this formation but seems to have the characteristic of broadening out the grain boundary into a dark line. From this

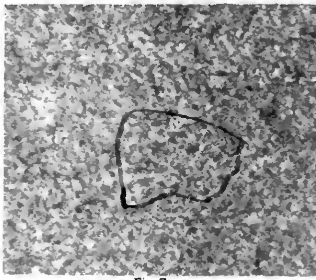


Fig 7

Fig 8

state the entire grain begins to etch a little more rapidly and take on a darker color, but the ground mass of the grain does not appear to alter in general characteristics as is usually found in the transformation from Austenite, Martensite, Troostite, and Sorbite, as understood as applying to the usual form of alloy steels or carbon steels.

Two very interesting photomicrographs are shown: Fig. 7, 400 magnifications, showing an extremely fine structure; one grain has been outlined. For reference the large outline has been followed but it is quite reasonable to regard this as not being the correct grain size at all, but rather the boundary line of probably a thousand smaller grains.

The other photomicrograph, No. 8, shows this same specimen at 1200 magnifications. The photograph in question represents about one grain as depicted in the former photograph, but as can be very readily seen, this grain appears to be a mass of grains. It is well to bear in mind the fact that pure metallic tungsten works best when one grain is worked, rather than when it is a number of grains. The tungsten wire drawers for metallic filaments are quite cognizant of this very important point. It is fair to argue that if the body is one grain, it would only have one weakness, and that would be the weakness of the grain; whereas if it is composed of a large number of grains, you have the two weaknesses of the intergranular or inter-crystalline weakness and the weakness of the crystal itself.

It is not suggested that this steel is one grain in any sense, but it does seem to have the characteristic of being similar in many instances to one homogeneous grain. Fractures have been made in this material and they do not seem to follow any particular outline in the steel. It is of no practical value to theorize whether or not this material is composed of a tremendous number of small grains or a smaller number of large grains. The practical utility of this steel is well demonstrated by the experiences related and the evidence shown and we believe that it represents a very radical and new departure in the era of chisel steel, and will materially reduce the cost of this class of tool steel in the shops and overcome a very large number of the difficulties and dangers now present with chisel steels.

There seems to be a general tendency on the part of users of chisel steel to just buy chisel steel as the requisition is handed in and let it go at that, knowing that chisels break, wear out and have to be redressed, and no careful check is kept as to the efficiency of this material.

We think the time has now arrived when as much interest will be expressed in the working efficiency of chisel steel in shops and the cost of this material per pound of chips removed, or other suitable calculations, as is being exercised with the modern high speed steel.

A Copper Alloy.

A copper alloy said to have the hardness of steel and of great tensile strength has been successfully experimented upon in France. It consists of 1 lb. each of chromium and aluminum, and adding 22 lbs. of copper, 5 lbs. of nickel and 4 lbs. of zinc, with intervals of between half an hour and an hour between the successive additions to the fused mixture. By varying the proportions of chromium and copper the alloy is said to give a considerable range of properties, with adaptation to many uses.

The Use of Scrap.

An expression of opinion in regard to scrap material has been issued by Director General Hines in which he states that the railroad officials are not in all cases exercising care in the sale of old material. He further claims that material is being sold promiscuously, much of which might be reclaimed, and issues directions that nothing should be sold that could be put to use in other ways.

Air Brake Department

Air Brake Convention — Questions and Answers

Air Brake Convention.

The twenty-sixth annual convention of the Air Brake Association will open at 9:30 a. m., May 6, at the Hotel Sherman, Chicago, Ill. The convention is scheduled to last for three days only, with morning and afternoon sessions each day. Frank McManamy, Assistant Director, Division of Operation, United States Railroad Administration, has issued a circular to the various Regional Directors, requesting them to send as many as possible of their air brake men to this convention. F. M. Nellis, secretary of the association, advises that from present indications the attendance this year will be greater than at any previous convention. This will doubtless be due to the meeting place this year being central and through Mr. McManamy's desire to encourage the worthy objects of the Air Brake Association.

The subjects to be presented are as follows: (1) Air Consumption of Locomotive Auxiliary Devices, by C. H. Weaver and committee; (2) Air Leakage and Money Wastage Through Failure to Keep Hose Couplings in Standard Gauge, submitted by the Manhattan Air Brake Club; (3) Recommended Practice, by H. A. Clark, committee and secretaries of the several air brake clubs throughout the country; (4) M. C. B. Air Brake Defect Card, by Jas. Elder; (5) Instructions on Freight Car Brake Maintenance, by Mark Purcell and associates; (6) Holding Standing Trains and Cars on Grades, by R. J. Watters; (7) Damage to Air Brake Equipment by Thawing Plants, submitted by the Northwest Air Brake Club; (8) Braking Ratio of About 40 Per Cent and Inside Release Valve for Caboose Car, submitted by the Northwest Air Brake Club; (9) How Can Enginemen and Trainmen Assist in Air Brake Maintenance? by H. A. Glick; (10) A. Resumé of the Air Brake Supervisor's Responsibilities to the Stores Department, by the Montreal Air Brake Club.

It will thus be seen that the subjects embrace important problems in air brake service, and the papers and discussions cannot fail to be instructive.

The exhibit spaces contracted for exceed those of any other previous year, and all innovations and improvements made in air brakes and air brake supplies during the past year will be exploited by exhibitors at this convention. One of the most satisfactory meetings from the viewpoint of live subjects and active discussion is expected from this convention, details of which will be published in our next issue.

Questions and Answers.
Locomotive Air Brake Inspection

(Continued from page 118, April, 1919.)

741. Q.—How is a steam cylinder efficiency or speed test conducted?

A.—By regulating the air pressure to 60 lbs. for the 9½ in. and to 66 lbs. for the 11 in. pump, and to 53 lbs. for the cross compound compressor and to 90 lbs. for the figures available for the No. 5 and 6 duplex compressors, and with the throttle wide open, the speed at the maximum will be about as follows in single strokes of the high pressure steam piston:

Steam Pressure	9½"	11"	8½"	5B	6B
100	150	136	50	42	
110	160	150	75		
120	170	160	100	78	
130	180	170	120		
140	188	178	134		
150	192	184	146	98	116
160	200	190	158		
170	204	196	166	110	138
180	208	200	174	116	145

742. Q.—This being maximum speed for a compressor in good condition, what should be expected of a compressor just overhauled or what might be a condemning point for a compressor in service?

A.—A speed of from 65 to 70 per cent of these figures.

743. Q.—About what is the maximum capacity of the 9½ in. pump, with 200 lbs. steam pressure with a wide open throttle against 100 lbs. air pressure.

A.—From 40 to 45 cubic feet of free air per minute.

744. Q.—At about what rate of speed will the pump be running at this time?

A.—About 175 strokes per minute.

745. Q.—What is the capacity of the pump at 120 single strokes per minute against 100 lbs. air pressure?

A.—From 28 to 30 cubic feet of free air per minute.

746. Q.—What is the maximum capacity of the 11 in. pump with 200 lbs. steam pressure working against 100 lbs. air pressure?

A.—About 60 cubic feet of free air per minute.

747. Q.—What will be the piston speed at this time?

A.—About 150 single strokes per minute.

748. Q.—What is the capacity of this pump at 100 single strokes per minute against 100 lbs. air pressure?

A.—About 45 cubic feet per minute.

749. Q.—What is the capacity of the 8½-in. compressor at 50 cycles or 100 single strokes per minute?

A.—About 85 cubic feet of free air per minute.

750. Q.—What is its maximum capacity against 100 lbs. air pressure with 200 lbs. steam pressure?

A.—About 130 cubic feet of free air per minute.

751. Q.—What will be the piston speed at this time?

A.—From 140 to 150 single strokes per minute of the high-pressure steam piston.

752. Q.—What is the maximum capacity of the No. 5 compressor with 200 lbs. steam pressure working against 100 lbs air pressure?

A.—About 100 cubic feet of free air per minute.

753. Q.—What is its speed at such a time?

A.—About 60 cycles or 120 single strokes per minute of each piston.

754. Q.—What is the maximum capacity of the No. 6 compressor, 200 lbs. steam against 100 lbs. air pressure?

A.—About 80 cubic feet of free air per minute.

755. Q.—What will be its piston speed under this condition?

A.—About 75 cycles or 150 single strokes per minute.

756. Q.—What is the effect of too much lift of air valves in a compressor?

A.—It reduces the efficiency of the compressor, by allowing too much air pressure to pass it before it re-seats after a movement.

757. Q.—Has too much lift any other bad effect?

A.—It also causes an unnecessary amount of wear on the valves and seats, with an excessive amount of lift, a steel valve in a short time is driven entirely through a discharge valve cage.

758. Q.—What drives the valves down into the seats?

A.—The high main reservoir pressure that seats them.

759. Q.—Are these valves not seated by gravity?

A.—The receiving valves might be, but the noise made by discharge valves in seating does not indicate that they are seated by gravity.

760. Q.—How can a man who has had years of experience with compressors tell when valves have an improper lift without making an examination?

A.—By holding his ear against the main reservoir, and by holding a pencil loosely against the valve cage or valve chamber cap.

761. Q.—Why is too much lift of air valves especially detrimental to the large capacity compressors?

A.—The heavy pound of the pistons caused by too much lift of air valves quickly loosens the compressors and brackets and breaks off the bracket studs in the boiler.

762. Q.—What percentage of time should a compressor be in operation after the required pressure has accumulated in the brake system?

A.—It should not be laboring hard or running at a fast speed over 50 or 75 per cent of the time.

763. Q.—What is the effect of continuous operation of the compressor?

A.—The compressor becomes overheated.

764. Q.—About what is the temperature of compressed air discharged at the end of one hour's continuous service?

A.—From 400 to 500 degrees F.

765. Q.—How is the overheating prevented on compressors built for continuous service?

A.—The air cylinders are water-jacketed.

766. Q.—When a compressor, during an orifice test, fails to maintain the required air pressure, to about what extent has it deteriorated?

A.—It is considered that with the sizes of openings specified by the Federal Regulations, the compressor is then less than 75 per cent efficient.

767. Q.—What causes compressors to make short strokes?

A.—Usually a bad leak on the seat of the reversing slide valve.

768. Q.—What causes the leak?

A.—A worn seat in the reversing valve bushing or a bent valve rod.

769. Q.—What causes the short stroke with the duplex compressor?

A.—The same defect in the reversing valve and bushing. If with the A or B style of compressors, the packing rings of the valve stems are worn out, and too loose in the bushings.

770. Q.—How does this cause the compressor pistons to be reversed before they can complete the stroke?

A.—The reversing valve is not held to its seat on account of the pressure surrounding it being equal and the weight of the rod caused the valve to move and reverse the compressor piston.

771. Q.—What is generally wrong when there is a blow back from the receiving valves of a compressor?

A.—The wings of the valves are too loose in the cages or the valve seats.

772. Q.—How does this cause them to leak?

A.—The "wobble" or looseness from an imperfect bearing or more than one bearing on the seats.

773. Q.—What is generally wrong when a compressor will not draw in any air on the up stroke of the piston when an examination of the air valves discloses no defects?

A.—It indicates that the passage from the receiving valve to the cylinder is closed.

(To be continued.)

Train Handling.

(Continued from page 119, April, 1919.)

784. Q.—How is the brake on an engine "bled off"?

A.—By means of the independent brake valve.

785. Q.—How does an angle cock handle stand when the cock is open?

A.—In line with the pipe.

786. Q.—The signal pipe stop cocks?

A.—Cross ways of the pipe when open.

787. Q.—How can it be determined whether a cock is open or closed if the handle is missing?

A.—By the groove cut in the top of the key, which runs in the same direction as the opening through the cock.

788. Q.—How is a brake cut out?

A.—By closing the stop cock in the brake pipe branch and bleeding the reservoirs, leaving the cocks open.

789. Q.—Why should the air be drained out of the auxiliary reservoir?

A.—To prevent the possibility of the brake applying.

790. Q.—What is wrong if the signal system is fully charged and the whistle will not sound?

A.—The signal valve is defective, or the bowl of the whistle itself is improperly adjusted.

791. Q.—Any other cause outside of a defective signal valve?

A.—The port in the bottom or valve's seat may be closed or the pipe to the whistle may be broken or have a hole in it.

792. Q.—What is indicated by two blasts of the whistle for one pull on the cord?

A.—That the diaphragm of the signal valve is in a bad condition, or that the diaphragm stem is too loose in the bushing.

793. Q.—What could be wrong if the signal pipes of the train could not be charged?

A.—Either the signal pipe is open, or the choke fitting in the non-return check valve is stopped up.

794. Q.—Could not the reducing valve piston be stuck closed?

A.—Yes, but in this event there would be no independent brake.

795. Q.—What is generally the minimum number of blasts for a signal?

A.—Two blasts.

796. Q.—Is one blast ever used for a signal?

A.—In some cases when brakes are sticking.

797. Q.—What should the engineman do in the event of one blast of the whistle?

A.—Answer with two short blasts of the engine whistle.

798. Q.—And if the one blast is immediately repeated?

A.—It is to be taken as a signal that brakes are sticking.

799. Q.—What must then be done?

A.—Move the brake valve to release position and quickly back to running position.

800. Q.—And if this does not release the brakes?

A.—Make a full service application of the brakes and release.

801. Q.—And if this does not accomplish a release?

A.—The train must be stopped and the brakes examined and defective brake cut out.

802. Q.—Would you ever take an engine away from the engine house with an inoperative driver brake?

A.—No; it would be a violation of the law.

803. Q.—How about an inoperative tender brake?

A.—It is also a violation to run an engine with the tender brake cut out.

804. Q.—Would it be a violation of the law to cut out a tender brake after coupling to a train?

A.—Not if the percentage of operative brakes was over 85 per cent.

805. Q.—What does cutting out a defective brake produce?

A.—A defective brake on the entire train.

806. Q.—In what way?

A.—The entire system is one complete brake, and any pair of wheels in a train that are not properly braked produces a defective brake, or one less efficient than if all wheels were properly braked.

807. Q.—Can an engine leave the engine house with an inoperative signal whistle?

A.—The Federal Regulations specify that it must be known before each trip that the signal system, when used, has been tested and is in a safe and suitable condition for service.

808. Q.—Can the train leave the station with an inoperative whistle?

A.—Yes; but both the engineman and conductor must be notified and the division superintendent must be notified by wire.

809. Q.—Is it a violation of the law to cut out a driver brake en route?

A.—Not if it becomes defective on the line of road. It may be cut out if necessary and the engine may proceed with the train to a point where another engine may be secured or where repairs can be made.

810. Q.—What precautions are to be taken in this event?

A.—The speed of train will be maintained at a safe rate about yards and signal bridges, with a view of making an allowance in the stop distance to compensate for the inoperative brake.

812. Q.—Can an engine haul a train when the air compressor is broken down?

A.—Yes, on orders from the division superintendent.

813. Q.—What precautions are to be taken if orders are given to move?

A.—To have the train under control, and proceed at such a speed that the train may be stopped in a reasonable distance with hand brakes.

814. Q.—What could be done in the event of an equalizing portion of a distributing valve becoming inoperative out on the road?

A.—The independent valve could be used in conjunction with the automatic brake valve to operate the driver brakes.

(To be continued.)

Car Brake Inspection.

(Continued from page 119, April, 1919.)

697. Q.—Is there any air pressure in the other three compartments or reservoirs?

A.—No, they are open to the atmosphere.

698. Q.—What is the result of a brake pipe reduction?

A.—The triple valve is moved by the auxiliary reservoir pressure and the auxiliary reservoir pressure flows to the brake cylinder in the usual manner.

699. Q.—Is the load cylinder used in any manner when the brake is being operated in the empty position?

A.—No.

700. Q.—What features has the triple valve?

A.—The uniform recharge, quick service and retarded release of the ordinary type K valves.

701. Q.—What action occurs when the brake is used in emergency position of the brake valve?

A.—The triple valves operate in quick action same as other valves.

702. Q.—What action occurs if the brake system is charged and the operating lever is moved to load position?

A.—The pressure is discharged from the back of the change over valve piston, and the pressure in the change over slide valve chamber forces the change over piston and slide valve to load position.

703. Q.—What chambers are then charged?

A.—The load reservoir and the take-up reservoir.

704. Q.—What is the size of these reservoirs?

A.—The take-up reservoir contains about 160 cubic inches and the load reservoir about 550 cubic inches.

705. Q.—What is the capacity of the auxiliary reservoir?

A.—2,440 cubic inches.

706. Q.—What occurs when a brake pipe reduction is then made with the additional chambers charged?

A.—When the triple valve moves to quick service position, air from the brake pipe, auxiliary reservoir and from the take-up reservoir flows into the empty brake cylinder, as well as a flow from the load reservoir.

707. Q.—How does take-up reservoir pressure enter the empty brake cylinder?

A.—Through the triple valve and change over valve.

708. Q.—When does the load cylinder come into operation?

A.—After 24 lbs. pressure has accumulated in the empty brake cylinder.

709. Q.—What amount of brake pipe reduction is necessary to produce 24 lbs. pressure in the empty cylinder?

A.—About 7 or 8 lbs.

710. Q.—What governs the cutting in point of the load cylinder?

A.—A spring loaded valve in the change over valve portion that is set or has a tension of 24 lbs.

711. Q.—Why is this quick rise in empty brake cylinder pressure desired?

A.—To provide the proper brake cylinder pressure per pound brake pipe reduction to compensate for the added load on the car.

712. Q.—For the first 7 or 8 lbs. brake pipe reduction an adequate braking force is provided for the heavily loaded car through what?

A.—A higher brake cylinder pressure in the empty car brake cylinder.

713. Q.—And after the 8 lbs. reduction or the attainment of 24 lbs. cylinder pressure?

A.—By an increased brake piston area.

714. Q.—When the load cylinder comes into operation, is the braking force not instantly doubled, both brake cylinders being of the same diameter?

A.—No, because the reduction reservoir is used at this time.

715. Q.—When the pistor area is then doubled, how is the brake cylinder pressure affected?

A.—The expansion of the empty brake cylinder pressure into the load cylinder and into the reduction chamber halves the pressure or the pressure in both cylinders is then 12 lbs.

716. Q.—How is it that a reduction reservoir is required?

A.—Because of the short piston travel of the load cylinder.

717. Q.—What is this piston travel?

A.—About 1½ ins.

718. Q.—Why this short travel?

A.—So that the necessary braking force may be derived from a trifle more compressed air volume than that required for the operation of the single capacity brake.

719. Q.—If the reduction is then continued?

A.—The brake cylinder pressure is built up uniformly with that of other single capacity brakes.

720. Q.—Where is the added volume derived from?

A.—The reservoirs mentioned contribute a sufficient amount for the brake cylinder that has but 1½ ins. piston travel.

721. Q.—How is the travel maintained at 1½ ins.

A.—Through a special clutch and a notched push rod used with the load cylinder.

722. Q.—Does this travel not increase with shoe wear?

A.—This is all taken up by the empty brake cylinder.

723. Q.—What is its piston travel?

A.—The usual 8 ins.

706. Q.—Explain just how this is accomplished?

A.—The load cylinder does not operate until after the empty brake cylinder piston has taken all of the slack out of the brake rigging. The load cylinder can only add its piston pressure to that already developed by the empty cylinder.

724. Q.—Where is the load cylinder force then effective?

A.—On the piston lever of the empty cylinder.

725. Q.—What is the tendency of the load cylinder push rod when the empty cylinder piston takes up the slack in the brake rigging?

A.—To be pulled out of the load cylinder.

726. Q.—And when the load piston starts out of the cylinder?

A.—The clutch catches the notched rod and the added cylinder force does not result in an increase in piston travel over 1½ ins.

727. Q.—Is lap position of the triple valve the same as when only the empty cylinder is in use?

A.—Yes, the flow of pressure to the brake cylinders ceases.

728. Q.—What about quick action or emergency position?

A.—It is the same, the quick action parts are unseated and the quick action or sudden brake pipe reduction is transmitted throughout the train.

729. Q.—When a car is equipped with this type of brake, what is the service braking ratio for the car when empty?

A.—The generally accepted standard, 60 per cent. based on a 50-lb. brake cylinder pressure.

730. Q.—And the braking radio (full service) when the load cylinder comes into operation?

A.—Forty per cent of the total weight of the car and capacity load.

731. Q.—In running two cars, one with the standard single capacity brake and the empty and load brake cut in on a loaded car, what is the brake cylinder pressure that may be expected with each installation with 8 ins. piston travel each and a 7 or 7½ lb. brake pipe reduction?

A.—About 9 to 10 lbs. for the single capacity brake and about 24 lbs for the empty and load brake.

732. Q.—With the empty and load brake, what is the brake cylinder pressure per pound brake pipe reduction, approximately?

A.—About 6.5 absolute.

733. Q.—And the braking power or braking ratio per pound brake cylinder pressure?

A.—About .342.

734. Q.—When the load cylinder then comes into action, what change is there in cylinder pressure per pound brake pipe reduction?

A.—It changes from 6.5 absolute to 3.25 absolute.

735. Q.—And the braking ratio per pound brake cylinder pressure?

A.—Changes from .342 to .8 per cent.

736. Q.—How is the empty and load brake arranged for cutting in?

A.—Through levers and rods that open the back of the change over valve piston into the atmosphere.

737. Q.—Is this done manually?

A.—Yes, this must be done by some one after the car is loaded.

738. Q.—How is the apparatus arranged for the valves to be returned to empty position when the car is unloaded?

A.—It is arranged so that whenever the pressure in the brake system is depleted as it would be when the car is being unloaded, the change over valve will automatically return to empty position.

739. Q.—Is this ever varied?

A.—Yes, with some arrangements provisions are made for locking the change over valve in load position so that it cannot automatically return to empty position when the pressures are depleted.

740. Q.—If two complete brake equipments per car were used to provide an empty and load brake how much more auxiliary reservoir volume would be required?

A.—100 per cent more.

741. Q.—How much is actually added by the empty and load brake?

A.—About 22 per cent more auxiliary reservoir volume.

742. Q.—How is this determined?

A.——About 550 cubic inches load reservoir pressure is added to the standard auxiliary reservoir volume of 2440 cubic inches of the reservoir volume is increased 550/2240 or about 22 per cent

743. Q.—Is the brake pipe volume increased?

A.—No, the volume is unchanged.

744. Q.—Is the total increase in volume of compressed air on the car increased 22 per cent.

A.—No, only the auxiliary reservoir volume, the total increase in volume on the car would be 800 cubic inches of brake pipe volume added to the reservoir or 550/3240 or 17 per cent would be added

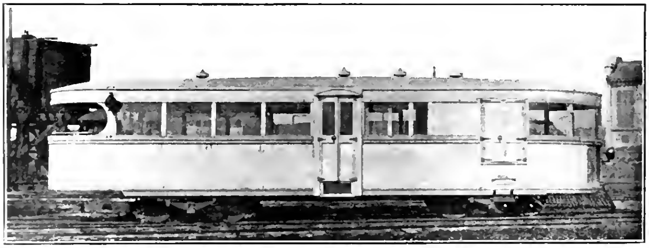
(To be continued.)

Gasoline Propelled Motor Cars in Interurban Service

By W. A. Hesse, M. M., Ocean Shore Railroad Company, San Francisco, Cal.

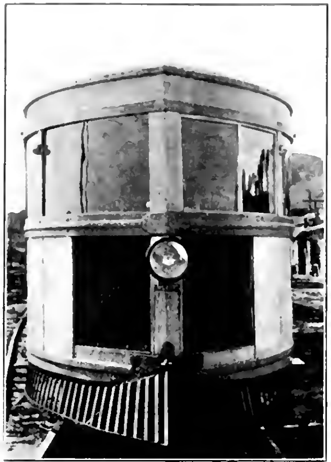
It is interesting to observe that various self-propelled motor cars have recently been developed, among which may be mentioned miniature steam locomotives and coaches combined, straight gasoline engine propulsion and electric propulsion with gasoline engine motor plant consisting of a gasoline engine directly connected to an electric generator, the current derived from same being fed to the motors located on the car trucks through controllers similar in design to the ordinary street car controller. In the gas-electric propulsion type of car the novel feature of control flexibility is claimed due to the current being fed to the electric truck motors in steps, without the necessity of changing the gas engine speed, except under special conditions and which from all accounts has proven very successful. One of the largest steam railroads in the United States, the Southern Pacific Co. of the Harriman Lines, has quite a number of gas-propelled motor cars in branch service and other railroads in various parts of the country have also tried out this type of motor cars. The cars are built in various types, including straight passenger, straight freight, combination passenger and baggage, combination passenger, smoker and baggage, and baggage and mail cars. These cars range in length from 50 to 70 ft., their weights approximating from 55,000 to 70,000 lbs. The seating capacity ranges from 55 to 105 persons. The engine is of the internal combustion, four-cycle type, using gasoline as fuel although special carburetors are also furnished for the consumption of distillate. The cylinders are six in number and the engine develops from 200 to 250 horse-power, according to the speed. Past trials have attested to the practicability of internal combustion engines for railroad service, viewed from the standpoint of low operating cost and maintenance compared with even the smaller types of regular steam locomotives which, with the weight of fuel oil or coal and water carried in the tender and the comparative great weight of the passenger cars, it will readily be seen that there is an excessive surplus weight transported which increases the cost of passenger transportation greatly in direct proportion to the fewer passengers carried.

The car shown in our illustrations was built by Meister & Son of Sacramento for the Commercial Cars Construction Company of San Francisco. Gas car No. 61 was the first turned out by the said company. The specifications are as follows: Body: Constructed of hardwood and steel with tenoned vertical posts or ribs. Lower framework supported by two 6-inch channels which extend along the sides of the car as far as the outer ends of the trucks and are provided with lugs to which the main semi-elliptical supporting springs are attached. The longitudinal channels are braced with cross channels of the same dimensions which are securely joined together at their intersections by means of triangular plates $\frac{3}{8}$ in. thick. The roof consists of hardwood carlines covered with narrow selected redwood strips which are in turn covered with muslin, outside and inside, heavily coated with white lead. The engine room is located in front, the smoker being next with toilet in center between the entrance and exit doors. The main part of the passenger compartment extends from about the center of the car to the observation platform at the rear, the individual seats being arranged along each side at an angle of 30 deg. Outside dimensions of car body are as follows: length 40 ft. 4 ins., width 7 ft. 6 ins., height 9 ft. Inside, height 7 ft. 3 ins., width 7 ft. The wooden frame is covered with 20-gage sheet steel plates which are grooved lengthwise for stiffening. Engine: Buda six-cylinder long stroke gasoline motor, model SSU, cylinders cast en bloc, 3¾ in. piston diameter by 5½ ins. stroke; 60 horse-power at 1,700 rev. per minute. Four-cycle type weight of engine with



SIDE VIEW OF MOTOR CAR. NO. 61, GASOLINE PROPELLED MOTOR CAR IN INTERURBAN SERVICE.

regular equipment about 675 pounds. Wheels: Four pairs, front truck 34 ins. diameter, rear truck 30 ins. diameter. Hardwood, built up with wooden rims



FRONT VIEW OF MOTOR CAR NO. 61. GASOLINE PROPELLED MOTOR CARS IN INTERURBAN SERVICE.

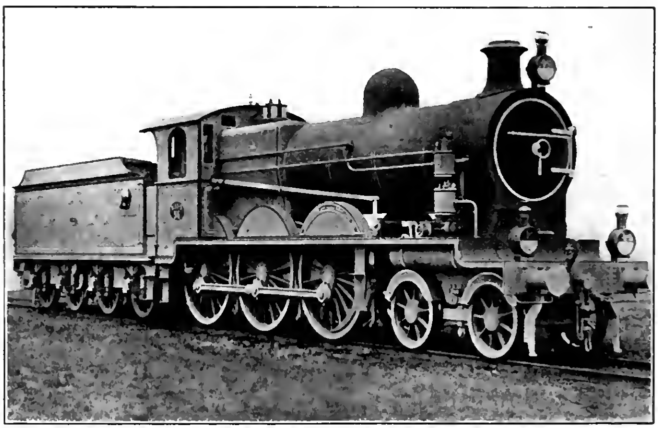
and interlocked spokes. Steel tires shrunk on rims and otherwise secured. Standard steel tires 1½ ins. thick, 4 ins. wide, M.C.B. face contour. Cooling system, water, operated by pump. Bearings: S.K.F. self-aligning type ball bearings on all axles. Generator: Bosch, connected to 12 volt storage battery, Gould. Smoker, nine persons. Rear compartment, including the observation platform, 22 persons. Total weight of car ready to run is 22,540 pounds. Brakes: two automobile band type acting on driving wheels on front truck, regular coach train brakes, outside hung, on rear truck wheels, actuated by ratchet handle in engine room. Curving radius: Sharpest curve car will take about 55 ft. radius. Wheel base: 24 ft. 10½ ins. Speed: About 45 miles per hour, maximum.

The aforementioned motor car arrived on the Ocean Shore Railroad on January 12, 1918. After preliminary tests the car was placed in service on regular schedule on February 18, 1918, in place of the steam passenger train and was taken off this service ou March 2, 1918. Maximum number of passengers carried on a single trip, 69. Average number of passengers carried, per trip, 26. After many trips over the Ocean Shore Railroad, on completion of the aforementioned test, the motor car was tested out over the Hetch Hetchy Railroad and also over the Northwestern Pacific Railroad, on both of which occasions the motor car successfully negotiated the curves and grades encountered. On return to the Ocean Shore Railroad it was found necessary to apply a heating system owing to the increasing intensity of cold weather. This was accomplished by applying a hood over the exhaust manifold and running a sheet iron pipe the length of the car, inside of which a 2-inch. iron pipe was fastened which acted as an auxiliary exhaust conveyance. Motor Car No. 61 has been in service more or less up to the present time, and this company has just placed an order with the Commercial Cars Construction Co. of San Francisco for two cars of somewhat larger seating capacity and more powerful engines. These new cars will be equipped with air brakes, air whistle and air operated bell ringer as well as other novel features to insure reliable operation.

Ten-Wheel Type Locomotive on the Holland Railroads.

By L. Derens, Utrecht, Holland

The first consignment of the type of locomotive shown in the accompanying illustration was built by Beyer Peacock and Company, Manchester, England, in 1908, and were adopted for saturated steam at a pressure of 200 lbs., the highest pressure used in Holland. They are the latest of their type of the 4-6-0 class, and have since been augmented in number by additions built by the Hohenzollern Actien Gesellschaft of Dusseldorf for the North Brabant-German Railway. They were also the first six-coupled express locomotives used on a Dutch railway. Their success has stimulated the other railway companies in Holland to follow the example.



4-6-0 TYPE OF LOCOMOTIVES ON THE RAILWAYS IN HOLLAND.

The heavy Flushing mail service across Holland to Germany necessitated the introduction of these powerful engines. Four of them are now equipped with superheater appliances. They haul the 400-ton mail trains at the required speed of 55 miles per hour between Boxtel and Wesel. When on one of these original consignments of engines a cylinder or other important part was to be renewed, it was furnished with a superheater, as the boiler and tubes were still in good condition. No less than 178 of the total 228 tubes were occupied by the superheater steam tubes, two in each tube, which brought the total boiler heating surface from 1,300 sq. ft. to 2,150 sq. ft.

The successful results obtained by the introduction of the superheater appliances were the reason that induced the Holland company ordering two additional engines, Nos. 36 and 37, both of which are equipped with the standard superheater, and from which the photograph reproduced was taken, as shown.

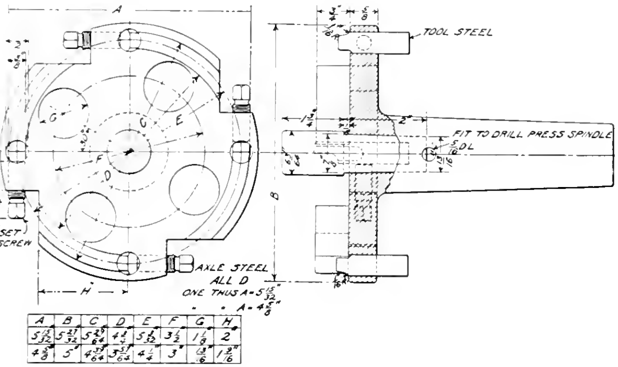
The general dimensions of this type of engine are as follows: Cylinders, 20 ins. diameter, 26 ins. stroke; driving wheels, 6 ft. 6 ins. diameter; boiler pressure, 190 lbs. Heating surface: Firebox, 149 sq. ft., tubes, 1,120 sq. ft.; superheater, 393 sq. ft.; total heating surface, 1,662 sq. ft. Adhesive weight, 43 tons. Total weight in working order, 61.6 tons. The tender has two four-wheeler bogies or trucks, and has a coal space holding 8.4 tons, and a water capacity of 4,400 gals.; the tender weighing in working order 51 tons.

Cutter for Superheater Boiler Flue Sheets.

By A. C. Clark, Pittsburgh, Pa.

The attached drawing shows the details of an improved design of tool for boring holes in flue sheets for superheater tubes. In starting the job, a hole 1 in. in diameter is drilled in the sheet as a guide for the pilot pin on the device. The end of the pilot pin fits into a tapered hole in the body of the cutter holder, and can be removed by driving pin in the hole and thus forcing it out.

Two of the cutters are for the purpose of cutting the hole in the sheet the desired diameter, and the other two cutters for chamfering the edge of the hole afterwards. The four corners, or recesses shaped or slotted out, from a



DETAILS OF CUTTER FOR SUPERHEATER BOILER FLUE SHEETS.

means of providing space for set screws that hold the four tools firmly in place. The rib ¾ in. deep, extending from the tool back to the place where it is cut out for the set screw, being slightly narrower than the diameter of the tool gives the cutter or tool an ample backing. This rib, or ring, is turned solid, being shaped or slotted out afterwards in four places as shown. Four holes "G" are drilled to make the tool lighter in weight. The upper end, or shank of the tool, is, of course, made to fit the drill press spindle.

Asbestos.

Asbestos is a Greek word, meaning "unquenchable," but used in the sense "inconsumable." It consists of silica, magnesia and lime or pyroxene. It was woven into cloth by the Greeks for wrapping dead bodies when they were burned in the funeral pyre that the ashes might be preserved. In ancient times the lamps that were always kept burning in the temples had wicks made from asbestos fibre. For many years after the revival of industrial activity asbestos was little used in the arts, and it is only recently that its usefulness has been fully recognized.

Care of Ashpans

A master mechanic on one of the leading railroads advises us that whenever they have engines at outlying points that do not reach the main terminals, the watchman is to be thoroughly instructed in keeping the proper record of ash pan maintenance and inspection, and in making any repairs in connection therewith which may be necessary. The master mechanic, when holding staff meetings to have men at outlying points who are responsible for the proper maintenance of ash pan and netting equipment present, and require them to present at the meeting books in which these records are kept. This also to apply to ash pan and netting inspection books kept at the terminal. These records to be thoroughly checked and carefully inspected.

Report on the Cost of Locomotive Fuel.

The Fuel Conservation Section, Division of Operation, United States Railroad Administration recently issued a statement showing the increase or decrease in the cost of locomotive fuel as shown in pounds used per thousand gross freight ton miles, and per passenger train car mile for the last five months of 1918, compared with the same period in 1917. The period referred to was taken as being reasonably comparable, from the standpoint of uniform weather conditions, absence of any general congested condition or other serious disturbing factor. The following summary of results based on the cost of coal, exclusive of the haul on users rails, has been abstracted from this statement:

ROADS FOR WHICH COMPLETE INFORMATION IS AVAILABLE

	Freight Train Service				Passenger Train Service		
Region	Per Cent of Total Mileage of All Roads	Total Savings	Per Cent Savings	Estimated Total Savings for All Roads	Total Savings	Per Cent Savings	Estimated Total Saving for All Roads in Both Passenger and Freight Service
Eastern	..	....	...	....	....	...	....
New England..	..	....	...	....	....	...	....
Division	36	106,169	4.5	$312,200	†$278,783	†6.1	$33,447
Central	37	1,328,364	11.2	2,297,000	564,338	8.6	2,861,338
Ohio-Indiana ..	65	349,079	14.0	472,500	63,061	7.1	535,561
Total Eastern..	54	1,783,612	10.0	3,081,700	348,646	2.9	3,430,346
Allegheny	66	1,260,053	9.3	1,856,000	101,227	1.4	1,957,227
Pocahontas* ..	15	....	...	....	38,528	4.6	38,528
Southern	70	145,817	1.5	208,000	98,951	1.7	306,951
Northwestern .	57	755,816	7.4	1,357,600	171,460	2.6	1,529,060
Cent. Western.	98	1,574,578	6.8	1,597,000	437,130	5.6	2,034,130
South Western	97	343,734	3.5	352,000	33,866	0.8	385,866
Grand total, all regions	97	$5,863,610	7.0	$8,452,300	$1,229,808	2.8	$9,682,108

* Pocahontas region freight train service total omitted, since information on which to base estimate is inadequate.

† Loss.

NOTE.—In determining the estimated total saving in freight train service for all roads in each region, it has been assumed that the average per cent saving for the whole region is the same as the average per cent saving for the roads in that region for which complete information is available. The grand total saving for all regions has been taken as the sum of the regional totals. The loss shown in passenger train service for the New England District of the Eastern Region is due to the extraordinary increase in cost of coal used in 1918 compared with 1917, the pounds of coal per passenger train car mile, 6.8 per cent less in 1918 than in the 1917 period. This statement does not include fuel used in mixed or special train service.

Hard Water.

The hardness of water is usually expressed in degrees, one degree being equivalent to a solution of one part by weight by carbonate of lime or other hardening salts to one hundred thousand parts of water. Wells generally contain the hardest water, 35 degrees of hardness being common. With water of one degree of hardness, the water contained in a single big tender would deposit 75 lbs. of mud or scale-making sediment.

A Good Scriber.

A scriber made from hard brass wire gives a fine light yellow mark on black metal surfaces, such as stove-pipe material, boiler plate and the like.

Electrical Department

Regenerating Braking as Applied to Electric Locomotives
What it Really Is

During the past two years regeneration as applied to the electric locomotives has been referred to many times. This feature is embodied in the electric locomotives operating over the Bluefield-Vivian division of the Norfolk & Western Railway and on the Chicago & Milwaukee electric locomotives hauling heavy freight over the mountains. To better appreciate what regeneration on a steam railroad of heavy grades means, it seems desirable to describe in a few words the operating conditions on the Norfolk & Western Railway where regeneration has been used with success.

The profile of the electrified portion of the road, including the famous Elkhorn grade, is shown by Fig. 1. Commencing at East Vivian, the average grade for 5¼ miles is 0.7 per cent; for the next 5¼ miles the average grade is 1.13 per cent with a maximum of 1½ per cent; for the next four miles the average is 1.66 per cent with a maximum of 2 per cent, the heaviest grade being through the Elkhorn tunnel.

Practically all coal is the freight handled, collected from numerous coal mines in the vicinity of Vivian and between that point and Columbus, Ohio. This means that the load is practically all one way against the grade, and therefore extremely heavy drafts of power are required from the power house.

The trains are made up on an average of 45 cars, totaling 3,250 tons, exclusive of the locomotive. The empties are made up into long trains, so that when descending the grade from Coaldale considerable experience and skill are necessary to take down the long empties safely and intact, with the use of air brakes.

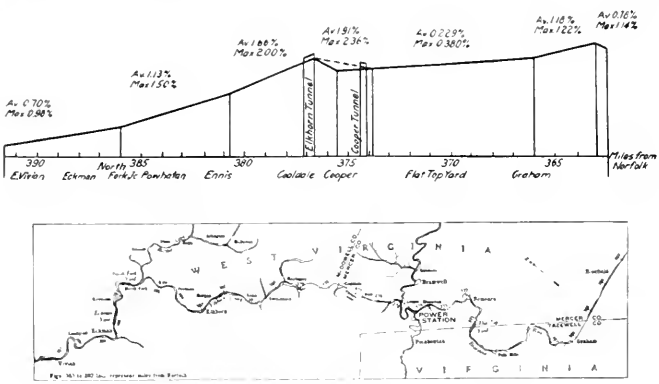


FIG. 1. MAP AND PROFILE OF ELKHORN GRADE ELECTRIFICATION NORFOLK & WESTERN RAILWAY.

A 3,250-ton train moving down the 2.36 per cent grade between Coaldale and Cooper represents considerable stored energy when expressed in foot pounds or horsepower. The horsepower can be calculated as follows: For each 1 per cent grade the downward pull is 20 lbs. per ton; i. e., if it requires 20 lbs. per ton to lift the train up the grade (disregarding train resistance for the time being) then the same energy exists to move the train down the grade. On the 2.36 per cent grade there will be then 47.2 lbs. per ton. The train resistance must be subtracted from this figure as it tends to hold the train back. Allowing 7 lbs. per ton for the train resistance, there will be a net amount of 40.2 lbs. per ton which with the train we are considering, made up of 3,250 tons trailing load and a 270-ton electric locomotive, will amount to 141,504 lbs. These locomotives operate at a constant speed of 14 miles per hour and regenerate as soon as the speed increases over this value by the smallest amount. At 14 miles per hour, the speed in feet per minute is 1,232. The energy in horsepower, and which must be dissipated by the brakeshoes as heat, is $141{,}504 \times 1{,}232 \div 33{,}000 = 5{,}285$ horsepower.

This value of horsepower is then available for useful work. Regeneration is the taking of this energy or power available on account of the train descending the grade, and converting it into electrical energy, returning same into the trolley wire and thus help to supply the power demanded by some other train ascending the grade. Less power is, therefore, taken from the main power station than would be the case without regeneration. Returning electric power to the conductor or trolley wire means that electric power is actually generated on the locomotive, and that the horsepower developed on the down grade is converted into watts of electrical energy.

The "watt" is the electrical unit, 746 of them being equivalent to one horsepower. We know power is required to generate electricity, and that for every 746 watts there is required one horsepower, providing the efficiency of the machine is taken is 100 per cent. We have learned that regeneration is the converting of the energy represented by horsepower into electrical power or watts, so that, if a method is provided for controlling the amount of power returned, this electrical power can be kept constant or can be varied to suit the grade which the train is descending. The amount of energy or horsepower available for regeneration is such that the speed of the train down the grade is under perfect control without the use of air-brakes, which are held in reserve for emergency and for stopping of the train.

Normally the electric motors supply the motive power for the propulsion of the train, but these are made use of to generate the electric current which is put back into the trolley wire. The motors are connected to the locomotive axles by gearing and side rods, or a combination of both, so that the armature of these motors revolve at all times with the revolution of the drivers. It is very interesting to know just how these motors are turned into generators, and how it is possible to return power to the overhead line. Take, for example, the Norfolk & Western locomotives. With these locomotives advantage is taken of the 2.36 per cent grade from Coaldale to Cooper. At this point the pusher locomotive is cut off from the rear of the 3,250-ton train. The whole train is then handled down the grade by regeneration. The ease with which the train changes from running to regeneration, and again at the bottom of the grade from regeneration to running is most remarkable. It is all the more wonderful to realize that this cycle of operation takes place with the least possible shock to the train.

Referring to the profile, there is a considerable change in grade at Coaldale—a

change from 1½ per cent up grade to over 2.3 per cent down grade. After a few cars of the train have passed over the crest, the engineman shuts off the electric power, changes over to regeneration position by a simple movement of a handle. When the master controller handle is again moved in, the locomotive begins to regenerate and picks up car by car as each comes over the crown of the hill. The change is equally simple at the bottom. When the locomotive reaches the dip, the master controller is thrown off, the locomotive changed over to running position, and when the master controller is again thrown on, the train is picked up car by car so that no shock is experienced. All of these operations are done with the train maintaining practically a speed of 14 miles an hour.

Regeneration is, in general, the same for all systems of electric traction, in that it provides a means for retardation of the train and for returning of power to the overhead line. There is, however, some difference, and we have divided same into two classes, namely, the systems having variable speed motors, the direct current and single phase systems, and the three-phase system.

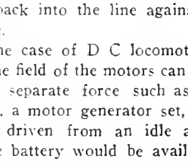
The series motor is so called because the armature and fields are connected in series and the same current flows through both. Fig. 2 shows these connections. With this arrangement the field varies with the load, which affects both the speed and the torque of the motor. The torque is represented by the product of the field strength multiplied by the current flowing through the armature. The pull, therefore, increases rapidly with increase in current, at a corresponding decrease in speed.

In order to regenerate on either of these two systems, the voltage generated by the motors must be greater than the voltage or pressure on the overhead trolley, and this pressure must be under control. The condition is similar to a water pipe, say, with water at a pressure of 100 lbs. In order to force water into this pipe, the pressure must be great enough to overcome the pressure in the pipe. The motors must temporarily become electric generators. As discovered by Faraday in 1831, an electric current at a pressure or voltage will be generated in conductors when moving in a magnetic field. The moving conductors cut the "lines of force" and the voltage depends upon the number of these lines of force cut in a given time. It is clearly seen, then, the stronger the field (that is, the more the number of lines of force) the higher will be the voltage at the same rate of cutting. Or with the same lines of force, if the conductor cuts at a greater rate, the voltage will also be greater. We refer to this point to make clear the arrangement followed.

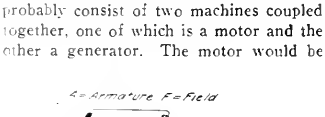
Take the locomotive. The armatures are driven by gearing or side rods. We have a magnetic field which can be produced by current flowing through the field coils. It is then only a question of combining and controlling these features, and we have a generator. It would be impossible to regenerate with the armature and field of the motor connected in series so that they must be split up. The change in connections is shown by Fig. 3. The field is disconnected from the armature and separately excited from some auxiliary power. The motor is now a shunt generator and by adjusting the amount of current flowing through the separately excited fields, thereby regulating the number of lines of force, sufficient voltage can be generated in the armature A to force currents back into the line against the line voltage.

In the case of D C locomotive operation, the field of the motors can be excited from a separate force such as a storage battery, a motor generator set, or a generator driven from an idle axle. The storage battery would be available at all times. The motor generator set would probably consist of two machines coupled together, one of which is a motor and the other a generator. The motor would be

A=Armature F=Field



Series Motor Connections
FIG 2



Connections for Regenerator
FIG 3.

connected to the line voltage or the trolley wire, and would run probably all the time either with the locomotive hauling or regenerating. The generator driven from the ideal axle would have the fields excited from the trolley.

If four or more motors are mounted on the locomotives, a wide variation of speed during regeneration can be obtained by combining the motors in the series and parallel combinations. During acceleration of the locomotive the motors are operated in combination starting, say, with 4 motors in series, then transferring to 2 motors in parallel and 2 of these parallel sets in series, and finally to the 4 motors in parallel. Three running speeds are thus possible, say, 8 miles an hour with the first arrangement, 16 miles an hour with the second arrangement, and 32 miles an hour with the 4 motors in parallel. These combinations work equally well in the reverse direction when regenerating. At the highest speed, say, 32 miles an hour, if regeneration is commenced, the motors will be used as 4 in parallel, as the train speed decreases, the combination would be changed over into 2 in parallel and two sets in series, and with further reduction in speed, the motors would be connected four in series. The reason for changing is apparent: as the train is reducing in speed the control must be such that more current is passed through the fields of the motors which are generating so as to keep the voltage up above the line voltage. As a certain number of lines of force must be cut during a certain time to give the voltage necessary, and since the reduction in speed cuts down the rate, it is necessary to increase the number of these lines of force so that the total number of lines cut will remain the same. There is a limit to the lowest speed, below which point it is not possible to keep up the field strength; hence it is necessary to change over to the second combination. With this combination of two motors in series, the voltage of each motor is added together so that sufficient voltage is obtained, and finally in the last combination of four motors in series all four voltages are added together to oppose and overcome the line voltage. The operation of the motors connected in series is analogous to a double-acting pump or compressor, where the air or water pressure obtained from the first piston passes into a high-pressure cylinder where it is increased to a much higher pressure by the movement of the second piston.

It should be understood that the circuits are all made or broken by switches, and the arrangement is such that they are all under perfect control of the engineer.

Removing a Refractory Stud.

Instead of drilling out broken studs and screws, drill a small hole in the center with an electric drill, and when the bottom of the stud or screw is reached fill the cavity with kerosene. If the screw is not then readily removable try two cap chisels on the surface, operating near the outer edges of the refractory screw, and a few blows on the chisels never fail to loosen the screw without in any way damaging the thread.

To Resharpen Old Files.

Wash the files in warm water to remove the grease and dirt, then wash in warm water and dry by heat. Put 1½ pints of warm water in a wooden vessel, put in the files, add 3 ounces of blue vitriol, finely powdered, and 3 ounces of borax. Mix well, and turn the files so that every one may come in contact with the mixture. Add 10½ ounces of sulphuric acid and ½ ounce of vinegar. Remove the files after a short time, dry, rub with olive oil, and wrap in porous paper. Coarse files should be kept in the mixture for a longer time than the fine ones.

Items of Personal Interest

J. S. Cullinan has been elected president of the Galena Oil Signal Company, succeeding Charles Miller.

Oscar Pierson has been appointed roundhouse foreman of the Santa Fe, with office at Argentine, Kan.

George F. Devine has been appointed master boiler maker of the Grand Trunk, with office at Island Point, Vt.

Richard K. Moore, general car foreman of the Canadian Pacific at Cochrane, Ont., has been promoted to district car foreman.

W. P. Connal has been appointed mechanical engineer of the Canadian National railways, with office at Toronto, Ont., resigned.

E. H. Utley, general manager of the Bessemer & Lake Erie, with headquarters at Pittsburgh, Pa., has been appointed Federal manager.

A. M. Darlow, general manager of the Buffalo & Susquehanna, with headquarters at Wellsville, N. Y., has been appointed Federal manager.

W. H. Maddocks has been appointed mechanical engineer of the Missouri, Kansas & Texas and affiliated roads, with headquarters at Parsons, Kan.

W. L. Mapother has been appointed federal manager of the Cumberland Railway, Artemus, Ky., to Anchor, Ky., with headquarters at Louisville, Ky.

James Finnegan has been appointed car foreman of the Chicago, Milwaukee & St. Paul, with office at Murdo, S. D., succeeding Frank Kulichka, resigned.

William H. Williams, chairman of the board of directors of the Wabash, has been elected president of the road, succeeding Edward F. Kearny, deceased.

W. C. Staley has been appointed supervisor of oil traffic Southwestern region, with headquarters at Kansas City, Mo., succeeding B. L. Swearingen, resigned.

Edward Griffin has been appointed night roundhouse foreman of the Rock Island, with office at Biddle, Ark., succeeding G. L. Hegberg, assigned to other duties.

W. J. Ormsby has been appointed master mechanic of the Wisconsin Division of the Illinois Central, with office at Freeport, Ill., succeeding F. Lawless, deceased.

A. L. Morgan has been appointed chief engineer of the Des Moines Union, the Iowa Transfer, the Des Moines Western and the Des Moines Terminal, with office at Des Moines, Ia.

E. W. Pratt, assistant superintendent motive power and car departments of the Chicago & North Western, with headquarters at Chicago, Ill., has been granted an extended leave of absence.

Frank G. Wallace, vice-president of the Canadian Locomotive Company, has been elected president to succeed the late Dr. J. J. Harty, and J. L. Whiting succeeds Mr. Wallace as vice-president.

A. H. Dixon has been appointed chief engineer of Western lines, Canadian National railways, succeeding the late A. T. Fraser, who was recently killed in a snow-slide at Nelson, B. C.

W. L. Webb, district engineer of the Chicago, Milwaukee & St. Paul, at Chicago, has been assigned to special work on the Chicago Union Station, and Lieut. C. F. Urbutt succeeds Mr. Webb.

Lieutenant W. H. Hobbs, having been released from military duties, has resumed his former duties as assistant engineer of the Louisiana Division of the Missouri Pacific, with headquarters at Monroe, La.

Samuel Jensen has been appointed assistant car foreman of the Chicago, Milwaukee & St. Paul, with office at Council Bluffs, Ia., succeeding Theodore Schmidt, transferred to a similar position at Sioux City, Ia.

C. A. Sasse has been appointed divisional car foreman on the Pennsylvania division of the Delaware & Hudson, with headquarters at Carbondale, Pa., succeeding F. S. Gangley, assigned to other duties.

L. C. Hensel, formerly electrical engineer of the St. Louis-San Francisco, with headquarters at Springfield, Mo., has become associated with the Gastin-Bacon Manufacturing Company, with office at Philadelphia.

Arthur E. Hoff, former industrial commissioner of the Erie, who has returned from service in the United States Navy, has been appointed assistant to the president of the Erie, and his former position has been abolished.

H. T. Anderson, superintendent of motive power of the Missouri, Kansas & Texas, at Parsons, Kan., has been appointed mechanical superintendent of the same road and affiliated lines, with headquarters at Denison, Tex.

C. M. Schramm, chief clerk to the mechanical superintendent of the Chicago, Rock Island & Pacific, with headquarters at Chicago, Ill., has been appointed assistant to the vice-president of the Vapor Car Heating Company at Chicago.

R. L. Irwin, purchasing agent of the Texas & Pacific, with office at Dallas, Tex., has had his jurisdiction extended over the Fort Worth Belt, and the International & Great Northern—Spring to Wort Worth, and Madisonville branch.

R. W. Burnett, superintendent of motive power of the Missouri, Kansas & Texas of Texas at Denison, Tex., has been appointed assistant mechanical superintendent of the same road and affiliated lines, with headquarters at Denison, Tex.

Harold R. Miles, assistant engineer on the Canadian Pacific, with headquarters at Montreal, Que., has been promoted to division engineer, with headquarters at Winnipeg, Man., succeeding H. K. Yorston, appointed locating engineer of the Canadian Pacific, Western Lines.

F. E. Doremus has been transferred as general Eastern manager of the E. L. Du Pont de Nemours Export Company, with headquarters at Shanghai, China, and E. R. Galvin has been appointed manager of the powder division of the company's products, succeeding Mr. Doremus.

George W. Ray, formerly roundhouse foreman of the Chicago & Alton at Brighton Park roundhouse, Chicago, Ill., has been appointed master mechanic in the same road, with office at Slater, Mo. Mr. Ray was employed in the mechanical department of the Frisco before coming to the Chicago & Alton.

C. S. Ogilvie has been appointed assistant engineer of the Grand Trunk, with headquarters at Ottawa, Ont., succeeding H. Mowatt. Mr. Ogilvie has just returned from a German prison, having joined the Canadian Expeditionary Force in the 13th Royal Highlanders, and had the misfortune to be taken prisoner in the second year of the war.

D. C. Fenstermaker, assistant engineer in charge of construction on the Chicago, Milwaukee & St. Paul, has been promoted to district engineer, with headquarters at Chicago, Ill., in charge of the Iowa, the Des Moines, the Kansas City, the Sioux City and Dakota and the Dubuque divisions, succeeding W. E. Wood, assigned to other duties.

A. M. Mueller, manager of the St. Louis branch of Joseph Ryerson & Son Company of Chicago, Ill., has been promoted to general manager of sales, and will have charge of all warehouse and mill products west of Pittsburgh, Pa., and William H. Basse has been appointed manager of the Detroit, Mich., plant of the same company.

A. A. Corey, formerly general superintendent of the Homestead plant of the Carnegie Steel Company, has been elected president of the Cambria Steel Company, Johnstown, Pa., and vice-president of the Midvale Steel & Ordnance Company, with headquarters at Philadelphia, Pa., and John S. Oursler succeeds Mr. Corey as general superintendent of the Homestead plant.

F. de St. Phalle has been elected vice-president in charge of foreign sales of the Baldwin Locomotive Works, and R. K. Johnson, a son of Alba B. Johnson, has been appointed foreign sales manager.

John P. Sykes, vice-president in charge of manufacture of the Baldwin Locomotive Works, has sailed for France, and while abroad will inspect foreign locomotive building plants.

M. K. Barnum, assistant to the general superintendent maintenance of equipment of the Baltimore & Ohio, with office at Baltimore, Md., has been appointed mechanical engineer for the corporation. Mr. Barnum is one of the most accomplished railroad mechanical engineers of our time, and has held the highest position in the mechanical department in nearly a dozen of the leading railroads, both Eastern and Western.

J. E. Anderson, purchasing agent of the Missouri, Kansas & Texas, the Denver & Rio Grande, and other roads in the Southwestern region, with headquarters at Dallas, Tex., has been appointed assistant purchasing agent of the St. Louis-San Francisco, the Kansas City, Clinton & Springfield, the Paris & Great Northern, the West Tulsa Belt Railroad, and the Rock Island-Frisco Terminal, with headquarters at St. Louis, Mo.

R. W. Spofford has been appointed local general manager of the Manila Electric Railroad & Light Company, Manila, Philippine Islands, by The J. G. White Management Corporation, New York, N. Y., the operating managers of that company. Mr. Spofford was graduated from the United States Naval Academy at Annapolis, and spent about five years in the navy. He was retired in 1911. Shortly thereafter he was engaged by The J. G. White Management Corporation and was assigned to the staff of the Augusta-Aiken Railway & Electric Corporation, Augusta, Georgia, and later was made general manager of that company. When the United States entered the world war, Mr. Spofford, as a naval reserve officer, was called to the colors for service. With the signing of the armistice he was again placed on the retired list of the navy, with the grade of lieutenant commander.

General Tripp was recently decorated with the United States Government distinguished war service medal, which was awarded him for his excellent work in systematizing methods and practice, resulting in the hearty cooperation of industries producing ordnance material for the army. Mr. Tripp's army career has been marked by a series of successes. Entering the army with the rank of colonel as Chief of the Production Division of the Ordnance Department, he was later promoted to the rank of brigadier general as assistant chief of ordnance. General Tripp has proven himself to be a man of wonderful executive and organization ability. It was he who conceived the idea that production work of the Ordnance Department should be handled from different points throughout the United States instead of through one big head in Washington. This scheme worked out to perfection and was the means of speedy and efficient production.

It is to men like Tripp that our country is indebted for the great part they played in assisting in the speedy and victorious end of the world war. Before going into service, General Guy E. Tripp was president of the Board of Directors of the Westinghouse Electric and Manufacturing Company, to which position he returned after the signing of the armistice, and the cessation of hostilities.

Manufacturers' Association.

The twenty-fourth annual convention of the National Association of Manufacturers will be held at the Waldorf-Astoria, New York, on May 19-21. Walker D. Hines, Director General of the United States Railroad Administration; Daniel Willard, president of the Baltimore & Ohio; William Starr Myers, of Princeton University, and others, are already arranged for to address the convention. Of particular interest will be the discussion on the future of the railroads.

Railroad Advertising

The United States Railway Administration has entered on a large national advertising campaign for the railroads that will run up into several hundred thousands of dollars. This regional advertising is not only going to cover the outdoor sports sections of the country, but also will show up the industrial regions. Opportunities offered along the various railroads are being illustrated, and an endeavor will be made to increase passenger traffic throughout the country. The regional directors of the railroads are working out plans for future campaigns and into their hands will be given the placing of the advertising contracts.

Canadian Railway Affairs

Proprietors of the British railway stock will glean little comfort from the attitude of the Dominion Government to the railways of Canada. Last week's revelations regarding the Grand Trunk Line not only disclose a woeful state of affairs, but convey the impression that the Canadian Government is prepared to take advantage of the misfortunes of the company to institute nationalization on the cheap. Briefly, the position is that the Grand Trunk Pacific—a subsidiary concern of the Grand Trunk Railway—having failed to fulfil earlier expectations, called upon the parent company to provide the interest on Pacific bonds which had been guaranteed. This the Grand Trunk Railway was unable to do, and financial assistance was asked from the Canadian Government. The matter was made the subject of a Royal Commission, and by a majority it was recommended that the Grand Trunk Pacific should be nationalized, and the suggestion made that the Grand Trunk might also be acquired.

Oil for the Bulgarian Railroads.

Chargé d'Affaires Charles F. Wilson has transmitted from Sofia, Bulgaria, a list of lubricating oils required by the Bulgarian State Railroads. The quantities are as follows (1 kilo equals 2.2 pounds): Engine oil, 1,300,000 kilos; cylinder oil, 500,000 kilos; superheated cylinder oil, 200,000 kilos; axle oil, 600,000 kilos; gas oil, 200,000 kilos; colza, 50,000 kilos; linseed oil, 30,000 kilos; kerosene, 40,000 cases; and benzine, 1,200 cases.

Mr. Hines on Flies

The director general of railroads advises us that there is probably no other public gathering place that is so popular as a rendezvous of the common house fly as the railroad stations and depots. The flies are attracted by certain unsanitary conditions frequently existing in such buildings and the litter from luncheons and other refuse which is scattered about and the opportunity to meet the representatives of other uncleanly communities who alight from the trains. The mild weather has been responsible for conditions that will promote the breeding and growth of this common enemy to all mankind and the serious war strain has debilitated both the physical and mental conditions of our people and made them susceptible to the ravages of disease. We know you are reluctant to placarding the railroad stations but we feel that the conservation of life is of as great importance as the conservation of food.

The Return of the Locomotives

In the operations of the Railroad Administration the pooling of locomotives to meet the exigencies of the national service has now been completed, and the locomotives have now been practically all returned to the roads on which they were originally operated. All are said to have been repaired and placed in good condition before being returned. The total number under lease to various roads was about 800, and it is generally admitted that during the year in which the system was in vogue excellent service was performed, greatly relieving the national emergency.

To Restore Rubber.

Those using articles made of rubber that frequently lose their elasticity through oxidization may restore the material to its original condition by a simple process. Soak the part in a mixture of one part of ammonia to two parts of water. It is particularly well adapted to the restoring of rubber bands, rings and small tubing that are ready to become dry and brittle.

Railroad Equipment Notes

The Commonwealth Edison Company, Chicago, is inquiring for one 66-ton concentrated-load well-car.

The Greek government is reported in the market for 500,000 steel railway ties of 242 pounds weight each.

The Federated Malay States Railways have ordered 12 locomotives from the Baldwin Locomotive Works.

The Chesapeake & Ohio plans to expend about $500,000 on extensive shop improvements at Huntington, W. Va.

The Great Northern Refining Company, Chicago, is inquiring for 125 8,000-gallon tank cars for lease for 90 days.

The Government of the Netherlands, Colonial Department, is inquiring for one motor inspection car for export.

The Magnolia Petroleum Company has ordered five 10,000-gallon tank cars from the American Car & Foundry Company.

The Broken Hill Proprietary Company has ordered six 50-ton steel hopper cars from the American Car & Foundry Company.

The New Howard Colliery Company, Huntington, W. Va., has ordered 59 cars from the American Car & Foundry Company.

The Department of Railways and Canals, Dominion government, plans to build shops and a roundhouse at Overbrook.

The Southern Alberta Refineries Company has ordered one 40-ton, 8,000-gallon tank car from the American Car & Foundry Company.

The Pennsylvania Equipment Company, Philadelphia, Pa., is in the market for 50 steel hopper and 50 steel gondola cars of 100,000 lbs. capacity.

The Kaijima Mining Co. (China) has ordered two 30-ton 6-wheel (0-6-0) switching locomotives from the American Locomotive Company.

The Pennsylvania Equipment Company, 1420 Chestnut street, Philadelphia, Pa., is in the market for 20 second-hand, 30 to 40 ton capacity flat cars.

The Cuban American Sugar Company, New York, has ordered 100 narrow gage cane cars from the American Car & Foundry Company for export to Cuba.

Robert Hudson, Ltd., Leeds, England, have ordered two Mogul type locomotives, weighing 37,000 lbs. and with 11 by 16 ins. cylinders, from the American Locomotive Co., for service in Portuguese East Africa.

The South Manchurian Railways have ordered 20 Decapod locomotives from the American Locomotive Company. These locomotives will have 23 by 28 ins. cylinders and a total weight in working order of 202,000 lbs.

The Kaijama Mining Company, China, has ordered two 6-wheel switching locomotives from the American Locomotive Company. These locomotives will have 12 by 18 in. cylinders, and a total weight in working order of 60,000 lbs.

The American Locomotive Company has just closed orders for 62 engines for foreign roads. The largest order is from South African railways for 40 mountain type engines, of which 20 will weigh 97 tons and 20 94 tons. The engines for South African railways will be built at the company's Montreal plant and others at its Cooke works.

The French government, through the French High Commission, has bought from the Director General of Military Railways 485 standard gage, Pershing type locomotives now being built by the Baldwin Locomotive Works, and 19,860 freight cars of various types that were under manufacture in the United States when the armistice was signed. There remains a comparatively small number of locomotives and cars yet to be disposed of and it is expected that they will be sold to some of the Allied governments.

During March the United States Railroad Administration delivered to the railroads under Federal control 250 locomotives, 112 of which were of the Mikado type, 62 Santa Fe, 41 switchers, 22 Pacific, 11 Mallet, and 2 Consolidation. It will thus be seen that the Mikado type continues to be chiefly in demand. In addition to these the American Locomotive Company constructed 26 miscellaneous locomotives for domestic service, and 32 locomotives to foreign countries, while the Baldwin Locomotive Works completed 96 locomotives for foreign service, and one for domestic service. Other firms constructed a considerable number of locomotives for domestic service, so that the total of new locomotives built in the United States in one month approaches 400. This is claimed to be the high water mark in locomotive construction.

Bulletins, Catalogues, Etc.

Spring Painting.

Dixon's *Graphite* for April points out with force and poetical beauty the need of spring painting to be in harmony with nature, which never errs. "When spring unlocks the flowers to paint the laughing soil," is the season when buildings, bridges, metal doors and shutters, tanks, smokestacks and other structures should be reconstructed with paint. Dixon's paint has stood the test of time, and it is well to paint once with Dixon's paint and be done with it. It comes in four colors, dark gray, olive green, dark red, and black. The trimming can be done in a lighter color. Send for a copy of *Graphite* to the Joseph Dixon Crucible Company, Jersey City, N. J., and learn all about their fine products.

Engineering College.

The University of Illinois comes out this year with an elegant pictorial descriptive Bulletin setting forth its many educational advantages. The constantly increasing number of buildings being added to the State University at Urbana, Ill., is the best proof of its growing popularity. In the department of railway engineering there is now one of the most complete locomotive testing plants in the world, which may be re-arranged to suit the dimensions of any locomotive. The same may be said of the various test cars, including electric and dynamometer cars and drop-testing machines. Copies of this Bulletin, No. 12, may be had on application to the University.

Westinghouse New Annual Catalogue.

A catalogue in which all of the electric supplies of the Westinghouse Electric & Mfg. Company of East Pittsburgh, Pa., are listed, has just been issued. There are 1,264 pages of descriptive matter pertaining to the products of the company, with tables showing the approximate cost of all supplies listed. The catalogue also contains a vast amount of information of a technical and engineering nature, and a copy should be in the hands of all interested in the utilization of electric power.

Boiler Water Treatment.

A Reprint of Engineering Bulletin No. 3, prepared by the United States Fuel Administration, contains valuable data in regard to boiler water treatment. The approved methods of heating water before it reaches the boiler is tersely explained. The appended reports from railroads and other industries substantiate the claims made in the Bulletin. Copies may be had from the Government Printing Office, Washington, D. C. Five cents per copy.

Manganese.

The use of manganese alloys in open-hearth steel practice is the subject of an exhaustive treatise by Samuel L. Hoyt, an eminent authority engaged in the war minerals investigations. As is well known, manganese is used for the purpose of purifying the steel during the process of heating, and although found in America in large quantities, it was looked upon as inferior to foreign products. The war has changed this, and means have been found to purify the home product, and in future we will use our own manganese. Copies of the Report, No. 11, may be had from the Department of the Interior, Washington, D. C.

Wilson Welding.

An illuminated booklet of 24 pages has been issued by the Wilson Welder & Metal Company, New York, manufacturers of the Plastic-Arc welding apparatus. A part of the booklet is devoted to a description of the repairing done on the damaged German ships that came into the hands of the Federal Government. The subject is of real interest as showing the complex work that can be done by the Wilson process. The illustrations are excellent.

Newton Machines.

Catalogue 49-A, issued by the Newton Machine Tool Works, Philadelphia, Pa., describes and illustrates three types of Newton slotting machines, as well as upright generating planers, locomotive link grinding machines, locomotive rod boring machines, milling machines and others. Most of these machines are equipped with recent improvements.

Liberty Bonds.

The Government Loan Organization, 120 Broadway, New York, reminds us that millions of our people have become holders of bonds, but some of them seem to feel that they are at liberty to sell them and use the money for unnecessary purposes. So they are. But they should not do so except under the spur of urgent necessity. There are no better securities in the world. A word to the wise is enough.

Advertising.

We are in receipt of a number of finely prepared pamphlets on the advantages of liberal advertising. The arguments are unanswerable. Not only is the advertising of a good thing the way to success, but it is a sign of success. We are entering upon a reconstruction period, and printers' ink is the pioneer of publicity which is the plain path to progress.

Annual Report of the New Haven.

A summary of the annual statement of the New York, New Haven & Hartford railroad company shows that, while the net income and resultant interest on the capital stock is not as large as would be wished, the improvement in equipment continues on an ample scale. During 1918, among other additions 1,500 hopper coal cars and 50 Santa Fe locomotives were placed in operation. For the coming year it is proposed to expend approximately $7,000,000 to continue the programme of improvements, the principal items being the Cedar Hill Yard and New Haven station improvements, engine house and shops in the vicinity of Boston, new and improved bridges and increased weight of rail, and other betterments.

Mechanical Convention Exhibits.

The demand for space for exhibits at the June Mechanical Convention is such that the Railway Supply Manufacturers' Association's Committee has been making efforts to extend the space with a view to admit additional exhibitors. In March almost every foot of available space had been taken up, amounting to about 90,000 sq. ft. It is therefore evident, as President Walker states, that there is an assurance of an overwhelming success as far as the mechanical exhibition is concerned. This is as it should be, and, doubtless, the attendance of those interested in the exhibits will be equally record-breaking.

Government Needs Boilermakers

Thirty first-class boilermakers are urgently needed at the United States Navy Yard at Norfolk, Va. Pay ranges from $5.36 to $6.40 for eight hours. Permanent employment is assured. Thirty days' leave with full pay is granted at the expiration of the first year of service, and for each month thereafter two and a half days' leave are allowed with full pay. When overtime is necessary, time and a half is allowed for all time in excess of eight hours. The Navy Department has authorized the Commission to furnish transportation to qualified men from point of departure to Norfolk, Va., if the men will agree to work for at least six months. U. S. citizens only will be considered. Full apprenticeship and good physical condition necessary. Application Form No. 1800 is required, which should be fully executed and filed with the Civil Service Commission at Washington, D. C. This form can be secured either from the Commission's office or from one of its field representatives. They are located in all of the larger cities of the United States.

Thrift a Solid Foundation.

Somebody has defined a Bolshevik as a man who has nothing and wants to divide it with everybody, says *Automotive Industries*. Very few of the anarchistic agitators in this country own any property.

When a man owns property he appreciates the necessity for well-organized legislation and for the necessity of enforcing laws. When the labor class as a whole in any community owns property it is a law-abiding and satisfied class. This is not only progressive in itself, but always carries with it a successful community. A beginning with War Savings Stamps may soon lead to the purchase of a home.

The Metric System

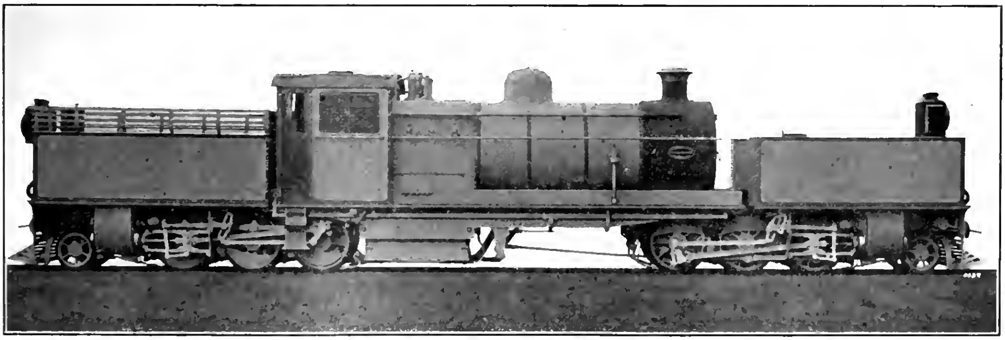
The propagandists of the metric system of weights and measures are at it again with renewed vigor, as if we had nothing else to think about except creating confusion. Our contractors have shown that they can build anything likely to be paid for in any kind of measure.

Railway and Locomotive Engineering

A Practical Journal of Motive Power, Rolling Stock and Appliances

Vol. XXXII — 114 Liberty Street, New York, June, 1919 — No. 6

The Demand for Railroad Equipment in South America and Other Foreign Countries



GARRAT TYPE OF LOCOMOTIVE IN SERVICE IN ARGENTINA, BRAZIL AND ELSEWHERE

The opportunities for American engineering enterprise, particularly in railroad equipment, has never had an opportunity in any way comparable to the present. The great war almost paralyzed railroad development. This is particularly true of the South American republics and the British and other colonies in Africa and Asia. Many of these countries had been largely supplied in the matter of railroad equipment from the British manufacturers, and during the war period, not only the British but other European railroad supply firms were wholly unable to meet the growing demands. That American constructors were also limited in their resources is true, but there was a surpassing degree of promptitude in meeting the emergency, owing in some measure to the late period at which America entered the war, but largely owing to the amazing capacity developed by American engineering adaptability to meet the situation. This has given America a great name abroad, with the result that the railroad enterprises all over the world are depending hopefully of meeting their difficulties in the lack of material on the United States as their stay in the immediate future.

Among these, Argentina is particularly prominent as a field full of promise and comparatively easy of fulfillment. With a stable government, it is in a position to meet its obligations, and its possibilities in development are enormous. It has already shown an enterprising spirit, as proved by the fact that while it has only about one-third the area of Brazil, it has nearly 25,000 miles of railroad in successful operation while Brazil has about 16,000 miles of railroad. Great schemes of importance were projected before the war, and are now being taken up. The expanding city of Buenos Aires is the center of the railway system, nearly all the lines radiating north, west and south from that city. The largest mileage is of the 5 ft. 6 ins. gauge, the next being of the metre gauge, with a limited number of the 4 ft 8½ ins. gauge. American engineers have shown equal facility in any kind of measurement or gauge, particularly if the orders for material come in sufficient quantities, the duplication of parts greatly facilitating the speed of construction, as has been shown in the rapidity with which the standard locomotives built to the order of the United States Railroad Administration were placed in service.

Coming back to the foreign equipment of locomotive known as the Garrett Locomotive which first appeared on the Western Australian Government railways, mostly in the narrow gauge type, and was latterly introduced in the Argentine, Brazil and other South American countries. The characteristics are well known among railroad men, but it may be briefly stated that the main feature in this articulated type of locomotive is the method of frame construction whereby the frame carries the boiler, instead of the boiler being superimposed upon the motor bogies or trucks, the boiler being carried between them, and pivoted to them at the extreme ends, the trucks supporting the driving mechanism as well as the fuel and water

tanks. It will be noted that there are no wheels under the boiler or tanks on the boiler frame, thereby placing no restrictions on the height of the boiler or size of the firebox. The system creates no difficulty in the way of axle loading. Even with the tanks nearly empty there is still sufficient weight on the trucks for the necessary adhesion. Not only so, but the element of flexibility is admirably adapted to sharp curves, the center line of the boiler frame forming a continuous true chord of the curve, the maintained center of gravity even at high speeds remaining at a correct degree of stability. The system is also well adapted on lines laid with light section rails, as well as on steep gradients.

The cylinders are fitted with inside admission piston valves and actuated by the Walschaerts gear. Double beat valves are provided on the dome with independent throttle valve rods and levers constructed so as to work together, and also to be readily disconnected. In regard to the steam pipes, one is taken to the smokebox, and the other is brought out through the back of the firebox and underneath the deck to the rear engine connecting pivot; the connection between the steam pipes and cylinders being made through a ball-joint on the center line of each pivot. The connection between the engine reversing shafts and the reversing gear is effected through the engine pivots by levers fitted with universal joints so that they act readily independent of the oscillation of the engine. The exhaust steam from the rear engine cylinders also passes through a ball joint near the center of the rear pivot into a pipe leading to an exhaust pipe in the smokebox. The engine is fitted with a combined vacuum and hand screw brake acting on the coupled wheels of each engine.

Some of the dimensions of this type of locomotive as adapted to the metre gauge and taken from those in service on the San Paulo railway in Brazil are as follows: Cylinders, 14 ins. by 20 ins.; main wheels, coupled, diameter, 3 ft. 6 ins.; bogie wheels, 2 ft. 3½ ins.; boiler, length, 10 ft.; diameter, 5 ft. 4 11-16 ins.; height from rail, 7 ft.; tubes, 339; diameter, 1⅞ ins.; firebox, length, 5 ft. 7¾ ins.; width, 5 ft. 3½ ins.; height, 6 ft.; outer shell, Belpaire stayed; heating surface, 1,865 sq. ft.; boiler pressure, 200 lbs.; tank capacity, smokebox end, 2,000 gals.; firebox end, 1,000 gals.; fuel, 400 cubic ft.

Of more recent construction and of more ample proportions, our second illustration shows a type of locomotive in service on the Central Argentine railway. It is of the 2-8-2 type for the 5 ft. 6 ins. gauge, with cylinder 19 ins. by 26 ins.; coupled wheels, 4 ft. 1 in. diameter; truck wheels, 2 ft. 9 ins. diameter; rigid wheel base, 14 ft. 6 ins.; total wheel base, 30 ft. 3 ins.; valve gear, Walschaerts; heating surface, tubes, 1,455 sq. ft., firebox, 139 sq. ft., total, 1,594 sq. ft.; grate area, 25 sq. ft., boiler pressure, 180 lbs.; tractive power, 29,308 lbs.; weight in working order, 84 tons, 15 cwts.; capacity of tank, 2,200 gals.; coal, 2½ tons; length over buffers, 39 ft. 10½ ins.; maximum width, 9 ft. 6 ins., height, 14 ft. 7¼ ins.

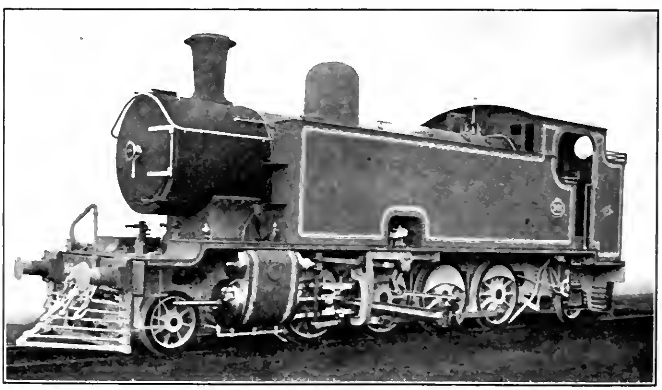
In regard to material the common British practice of copper fireboxes, and also brass tubes are in use on this locomotive, and these types of locomotive are illustrated as showing examples of the types that are in service not only in South America, but Australia, South Africa and elsewhere, and largely supplied by British engineers previous to the war and to which very little addition has been made during the war, although a considerable amount has been spent in the improvement of roadbeds in Argentina and elsewhere, as well as the double tracking of main lines, erection of new and larger stations, the electrifying of suburban lines radiating from Buenos Aires, and the improvement of port facilities and workshops. So many of these additions and betterments have been going on that official reports have shown that some of the companies have been severely criticized by their stockholders for the elaborate scale on which they have pursued this policy of improvement, and it is impossible to predict whether or not the railways will resume their pre-war plans for expansion. In the case of the European companies it will depend on the price of money at home as well as on the form which the proposed railway legislation in Argentina will take and the solution of the present labor problem. Almost without exception the companies have increased their reserve funds during the last four years, although they have been forced to pay very small or no dividends at all, and they are anxious to retain and expand their Argentine holdings, provided they are insured sufficient protection by the government, as well as a chance to make a reasonable profit on their capital investment.

There are no detailed statistics available for several years, but previous to the war the Argentine market for railway supplies of all kinds was varied and extensive. The electric suburban systems operated by the Central Argentine and the Western necessitate an entirely separate equipment, and the large freight terminals and the extensive docks at Buenos Aires require their own special equipment.

From the official reports the following table shows the quantity of rolling stock owned by each of the large companies in 1913—the year preceding the war:

Railroads	Locomotives	Passenger cars	Freight and other cars	Total
Central Argentine....	620	651	21,233	22,504
Buenos Aires Great Southern	627	786	15,200	16,613
Buenos Aires & Pacific	742	409	12,651	13,802
Buenos Aires Western	327	348	9,747	10,422
Cordoba Central	267	323	6,960	7,550
Central Norte	387	206	6,537	7,130
Province of Santa Fe	160	147	5,604	5,911
Province of Buenos Aires General Railroad	104	98	2,566	2,768
Entre Rios	84	94	2,168	2,346
Argentine del Norte..	66	100	1,829	1,995
Argentine Northeastern	68	74	1,136	1,278
Rosario Puerto Belgrano	44	28	1,094	1,166
Buenos Aires Central.	38	25	1,016	1,079
La Plata & Meridiano Quinto	21	25	923	969
Buenos Aires Midland	34	33	869	936
Central Railway of Chubut	6	7	86	99
State Development Railways	..	..	....	....
Total	3,595	3,354	89,619	96,568

It will be noted from this table that the Central Argentine, the Southern, and the Buenos Aires & Pacific normally require the largest amounts of rolling stock. These three companies maintain extensive shops in the Argentine where they not only do repair work, but manufacture a considerable amount of rolling stock. The Central Argentine has large factories at Rosario and Perez, where it has been building cars for several years. The shops of the Southern are situated at Talleres, where, among other railroad



TYPE OF TANK ENGINE ON THE CENTRAL ARGENTINE RAILWAY.

equipment, a special type of postal car is made. The Buenos Aires & Pacific has been building a distinctive ventilated fruit car for fast service between San Juan, Mendoza and Buenos Aires.

The administrative offices of the large British companies are, without exception, situated in Buenos Aires, but the executive officers are British and prefer to make their purchases in Britain when possible. The fact explains the predominant place previously occupied by Britain among the countries sending railway equipment to the Argentine during the five-year period (1909-1913) immediately preceding the war.

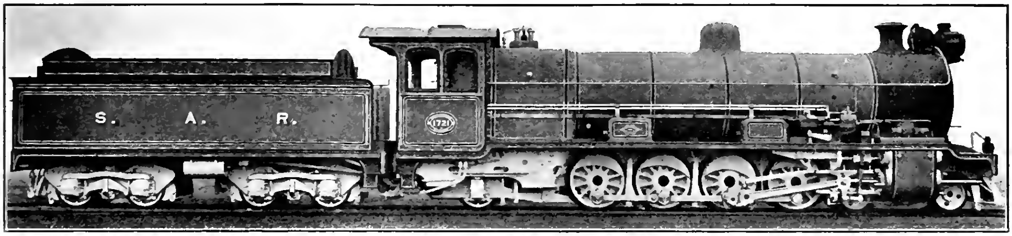
Since imports, not only of rolling stock, but of miscellaneous supplies of all kinds including raw materials have been so

hands of American manufacturers, and all that is required is a maintenance of that marked degree of promptitude in filling orders, which we have already referred to, in order to establish a rapidly growing market for American railway equipment in South Africa, as well as in other countries hitherto largely supplied from European manufacturers generally, and Britain particularly.

In this connection it will be of interest to note our third illustration showing a type of locomotive in the service of the South African railways. It is of the narrow gauge or 3 ft. 6 ins. type, and while of considerable length of wheel base is adapted to curves of a minimum of 300 ft. The following are the general dimensions: Cylinders, 22 ins. by 26 ins.;

trade for the railways in the near future.

Since imports, not only of rolling stock, but of miscellaneous supplies of all kinds including raw materials have been so greatly restricted for the past four years, the equipment of all the roads has become very materially depleted. The Patagonian State railways are reported to be especially hampered by lack of equipment. The Entre Rios, according to the latest company report, is in the market for one or more new train ferries. The annual purchases of the Government railways are said to amount to about 5,000,000 paper pesos. All the companies report that in view of high prices, the difficulty of obtaining supplies, and unsettled conditions in the Argentine, purchases have been



TYPE OF NARROW GAUGE LOCOMOTIVE ON THE SOUTH AFRICAN RAILWAYS.

greatly restricted for the past four years, the equipment of all the roads has become very materially depleted. The Patagonian State railways are reported to be especially hampered by lack of equipment. The Entre Rios, according to the latest company report, is in the market for one or more new train ferries. The annual purchases of the government railways are said to amount to about 5,000,000 paper pesos. All the companies report that in view of high prices, difficulty of obtaining supplies, and unsettled conditions in the Argentine, purchases have been reduced to the minimum.

Glancing briefly at the South African colonies, reports show that previous to the war the purchases for railway equipment approached $70,000,000 of supplies, yearly, but this has been decreased to about $20,000,000. This shows the extent to which the war reduced the amount of purchases, said in the reports to be about 15 per cent. of the normal purchases, the remainder being of local production. It has been particularly difficult to obtain rails, as their demand for pressing war service prevented the necessary supply from any source whatever. Deferred deliveries have been found to be unobtainable, and the South African colonies may be said to have ceased to hope for anything other than a limited delivery of material from Britain. This being the case it is not surprising that a considerable amount of orders have been already placed in the

coupled wheels, 4 ft. diameter; fixed wheel base, 12 ft. 9 ins.; leading truck wheels, 2 ft. 4½ ins. diameter; trailing truck wheels, 2 ft. 9 ins. diameter; total wheel base, 30 ft. 7 ins.; valve gear, Walschaerts; type of valves, piston; heating surface, tubes, 2,211.96 sq. ft.; firebox, 149 sq. ft.; total, 2,360.96 sq. ft.; grate area, 36 sq. ft.; superheating surface, 503.04 sq. ft.; boiler pressure, 190 lbs.; traction power, 37,309 lbs.; total weight in working order, 89 tons 4 cwts.; capacity of tank, 4,250 gals.; fuel space, 400 cubic ft.; weight of tank in working order, 50 tons 17 cwts. Maximum width, 9 ft.; height, 12 ft. 7½ ins.; total wheel base, 56 ft. 11¾ ins.; length over buffers, 65 ft. 4⅝ ins.; total weight in working order, 140 tons 1 cwt.; material in firebox, copper; tubes, steel.

A word may be said in regard to the financial outlook in the countries to which we have referred. Taking Argentina as an illustration, the 1917-18 net returns have in general been better than those of 1916-17, due to the 22 per cent. rate increase allowed in November, 1917, and this has been reflected in a rise in recent quotations in stock. The grain crop on which the railways are chiefly dependent for their export freight was large in 1917-18, and promises to be almost as good for the present year. The ending of the war means the gradual easing of the shipping situation, which will result in a larger volume of import freight

reduced to the minimum amount consistent with the maintenance of satisfactory service.

As to Mexico, the traffic situation is bad. A few years ago the National Railways had about 90,000 freight cars; now it has about 15,000. The skeletons of box cars burned by the revolutionists are turning to rust at nearly every siding in the republic. The locomotive situation is worse than the box-car situation. The company states that it needs about a hundred new locomotives to haul the freight offered. However, it has quite a number of engines at various points that have been put out of commission which would be put in running order if the country had the mechanics to do the work.

In conclusion, it should be borne in mind that the American manufacturers are by no means indifferent to the advantages of meeting the situation. The export of steam locomotives during February and March of the present year show that 112 locomotives have been shipped to foreign countries, about one-fourth of which were sent to France and some to Italy, the remainder being scattered among the countries which we have referred to, and indeed to every civilized country under the sun, and to some whose civilization, according to the light that has been given to us, might be improved upon. Toward this desired end, however, we exercise our souls in patience, and we are not praying for miracles.

Powerful Pacific Type Locomotive for the Lehigh Valley Railroad

During the winter of 1916-1917, the Lehigh Valley Railroad received, from The Baldwin Locomotive Works, a consignment of 30 locomotives of the Pacific type which were designated by the Railroad Company as Class K-5, and were notable because of their weight and capacity. These engines are soft coal burners, and they have been successfully used in both heavy passenger and fast freight service. The same builders have recently delivered to the Lehigh Valley a group of Pacific type locomotives designated as Class K-5-A, which differ from Class K-5 chiefly in that they have fireboxes sufficiently large for burning a mixture of anthracite and bituminous coal. This change has involved a slight increase in weight; and the new locomotives, with 204,560 pounds on drivers, a total weight of 311,900 pounds, and a tractive force of 48,600 pounds, rank among the heaviest and most powerful of their type. The ratio of adhesion is 4.20, so that full tractive force can be developed under average rail conditions, without slipping the drivers.

These locomotives were designed in accordance with drawings and specifications furnished by the Railroad Company, and are specially fitted for meeting the fuel and operating conditions on the Lehigh Valley. They are suitable for handling preference freight on level divisions in the anthracite districts, and also for express passenger service on the Wyoming Division, where the maximum grade is 96 feet per mile. They are therefore excellent combination locomotives, and in this respect may be compared to the Class J-55 Ten-wheelers built some years ago. Their tractive force, however, is 55 per cent. greater than that of the Ten-wheeled locomotives.

A comparison of the boilers of Classes K-5 and K-5-A shows that no change has been made in the lengths of the tubes and firebox, but the width of the grate has been increased from 90 ins. to 114¼ ins., and the depth of the firebox has been slightly reduced. Class K-5-A is fired with a Standard stoker, and the firebox contains a brick arch supported on six tubes. The combustion chamber is 48 ins. long, and all seams in the firebox and combustion chamber are welded. There is a complete installation of flexible bolts in the side water legs, and four rows of flexible stays support the front end of the combustion chamber crown. The grate is composed of table bars, and is arranged to rock in six sections. In order to provide a sufficiently deep water-space under the combustion chamber, a conical ring is placed in the middle of the barrel. This increases the shell diameter from 83¾ ins. at the first ring to 94⅞ ins. at the third.

These locomotives are equipped with Walschaerts valve gear, controlled by the Ragonnet power reverse mechanism. The reciprocating and revolving parts are comparatively light in weight, and special steels are used for the main and side rods, stub straps, and crank pins. When drifting, saturated steam can be admitted to the cylinders through a 1½-inch pipe, equipped with a line valve in the cab and having a 1-inch branch pipe to each cylinder steam pipe.

The frames have a width of 5¾ ins., and each main frame is cast in one piece with vertical knees to which the guide yoke and valve motion bearer are bolted. The Commonwealth rear frame cradle is applied. The driving pedestal wedges are self-adjusting.

The tender is carried on equalized pedestal trucks, and has a one-piece, cast steel frame. The water capacity, 8,000 gallons, is the same as that of Class K-5; but the fuel capacity has been increased from 12½ to 15 tons.

These locomotives represent practically the maximum capacity at present obtainable in a six-coupled engine designed for service on first-class track. The following are the principal dimensions:

Gauge, 4 ft. 8½ ins.; cylinders, 27 ins. x 28 ins.; valves, piston, 14 ins. diam.

Boiler.—Type, conical; diameter, 83¾ ins.; thickness of sheets, ¾ ins. and 13/16 ins.; working pressure, 205 lbs.; fuel, hard and soft coal mixed; staying, radial.

Firebox. — Material, steel; length, 120 1/16 ins.; width, 114¼ ins.; depth, front, 85 ins.; depth, back, 70 ins.; thickness of sheets, sides, ⅜ ins.; thickness of sheets, back, ⅜ ins.; thickness of sheets, crown, ⅜ ins.; tube sheet, ½ in.

Water Space.—Front, 5 ins.; sides, 4 ins.; back, 4½ ins.

Tubes.—Diameter, 5½ ins. and 2¼ ins.; material, steel; thickness, 5½ ins., No. 9 W. G., 2¼ ins., No. 11 W. G.; Number, 5½ ins., 45; 2¼ ins., 254; length, 17 ft. 6 ins.

Heating Surface.—Firebox, 244 sq. ft.; combustion chamber, 90 sq. ft.; tubes, 3,734 sq. ft.; firebrick tubes, 48 sq. ft.; total, 4,116 sq. ft.; superheater, 980 sq. ft.; grate area, 95.2 sq. ft.

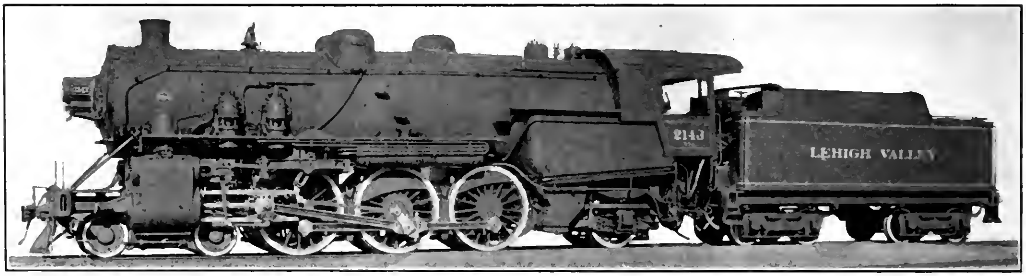
Driving Wheels.—Diameter, outside, 73 ins.; diameter, center, 66 ins.; journals, main, 13 ins. x 20 ins.; journals, others, 11 ins. x 14 ins.

Engine Truck Wheels. — Diameter, front, 33 ins.; journals, 7 ins. x 12 ins.; diameter, back, 51 ins.; journals, 9 ins. x 14 ins.

Wheel Base.—Driving, 13 ft. 8 ins.; rigid, 13 ft. 8 ins.; total engine, 36 ft.; total engine and tender, 68 ft. 9⅜ ins.

Weight.—On driving wheels, 204,560 lbs.; on truck, front, 52,140 lbs.; on truck, back, 55,200 lbs.; total engine, 311,900 lbs.; total engine and tender, 469,100 lbs.

Tender.—Wheels, number, 8; wheels, diameter, 36 ins.; journals, 5½ ins. x 10 ins.; tank capacity, 8,000 U. S. gals.; fuel, capacity, 15 tons; service, fast freight and passenger.



PACIFIC 4-6-2 TYPE LOCOMOTIVE FOR THE LEHIGH VALLEY RAILROAD.
Baldwin Locomotive Works, Builders.

Annual Convention of the Air Brake Association

Important Discussions Looking Towards the Saving of Fuel
Organization of the Air Brake Appliance Association

The growing importance of the Air Brake Association was emphasized by the large and enthusiastic attendance of members, 650 being present, besides many notable guests, at the twenty-sixth annual convention of the association held at the Hotel Sherman, Chicago, Ill., beginning on May 6 and continuing for three days. The subjects discussed, as announced in our columns last month, covered many important subjects engaging the minds of the leading air brake experts; and the reports and debates showed that much earnest thought had been given to the matters intrusted to the various committees, and the fine spirit and fluency of utterance shown by the members in the various discussions showed the educational advantages to be derived from the participation in such meetings.

PRESIDENT BARRY'S ADDRESS.

In the course of his opening address, President F. J. Barry spoke of the many improvements that had been made recently in adopting many of the recommendations made by special committees of the association, and especially their association with the train brake and signal committee of the Master Car Builders' Association, which had been closely co-operating with the executive committee of the Air Brake Association during the last year. A number of air brake clubs had also rendered excellent service by submitting suggestions of merit, which were embodied in papers submitted to the association. In closing his able address, President Barry took the opportunity to pay a glowing tribute to the late Walter V. Turner, director of engineering, Westinghouse Air Brake Company, who he truly claimed had been the originator of many of the most important advances made in the air brake appliances in the present century.

At the close of the president's address, First Vice-President T. M. Lyons presented a past president's badge to C. H. Weaver, who ably presided at the convention in 1918.

REPORTS OF THE SECRETARY AND TREASURER.

The growing popularity of the association was well illustrated in the report of the secretary, F. M. Nellis, who stated that the membership now approached 1,100. The need of a new book of instructions was pointed out, not only embracing the most advanced details of air brake service in the question and answer form, but a larger and more comprehensive work containing chapters describing the latest improvements, with details of operation, repair and lubrication. Mr Nellis spoke hopefully of the association getting out such a work in the near future in spite of the high prices of material.

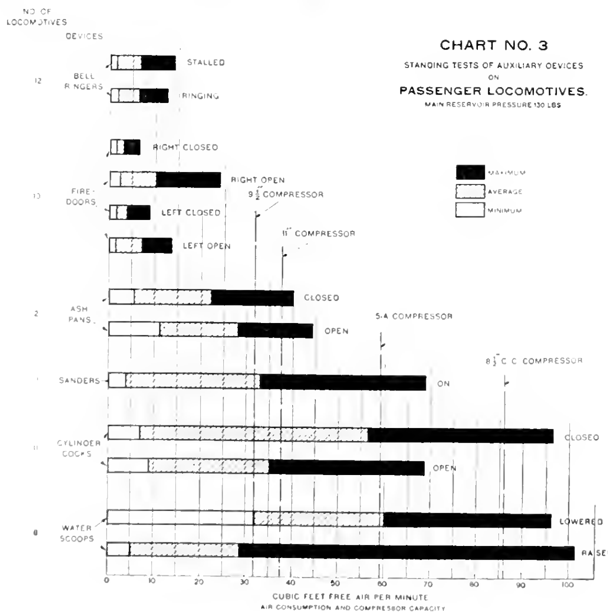
F. J. BARRY, PRESIDENT AIR BRAKE ASSOCIATION, 1918-19.

Treasurer Otto Best reported a balance of $2,919.96, and that $1,000 had been used in the purchase of Victory bonds in addition to a similar amount devoted last year to the purchase of savings stamps.

ADDRESSES BY CITY AND GOVERNMENT OFFICIALS.

On the first day the mayor of Chicago made a happy address of welcome, and Frank McManamy, assistant director of operation, United States Railroad Administration, spoke of the great value of the association in safeguarding railway transportation, and the need of a persistent endeavor looking towards the better maintenance of air brake appliances. He warmly commended the action of the Air Brake Association in making recommendations in regard to the correction of the losses incident to excessive air leakages, and stated that executive authority would be exercised in an effort to carry out more fully the recommendations.

W. G. Beird, Federal manager of the Chicago & Alton, spoke hopefully of the future in view of the fact that there was a growing feeling of cordiality and mutual helpfulness between employers and employees. He warmly endorsed the meetings of representative men of all classes engaged in railroad work and that the constant interchange of views in regard to every phase affecting conditions,

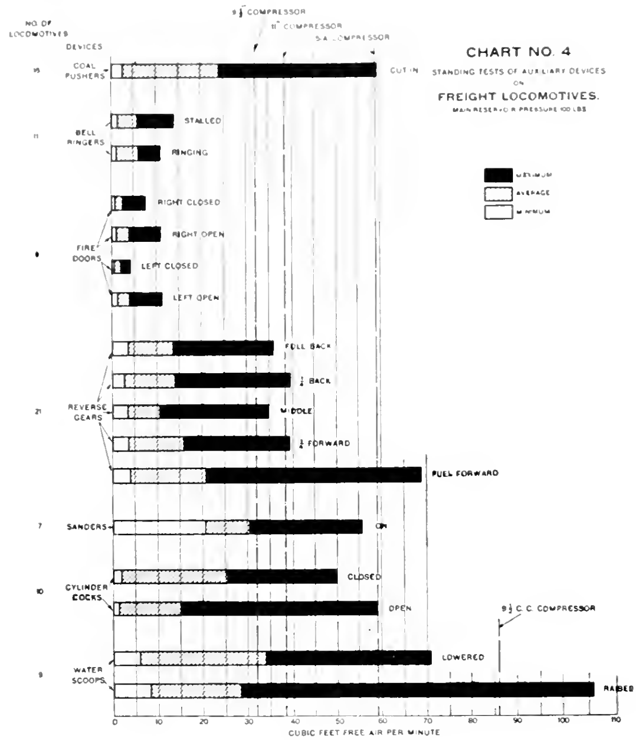


operation, equipment and repairs, could not fail to be beneficial.

W. J. Patterson, representing W. P. Buland, chief of the Bureau of Safety of the Interstate Commerce Commission, gave a resume of the Safety Appliance Act and its purposes, particularly in relation to air brake matters, and that the marked improvements showed that further rigid regulations were hardly necessary as far as the Air Brake Association was concerned.

AIR CONSUMPTION OF LOCOMOTIVE AUXILIARY DEVICES.

The report of the committee on the above subject, C. H. Weaver, chairman, contained details of a series of tests made for the purpose of determining the amounts of air used in locomotive accessories other than the air brake, including such devices as reverse gears, bell ringers, sanders, coal pushers, water scoops, fire doors and other appliances. The tests had been made on locomotives while standing as well as while running, and were accomplished by the use of calibrated reservoirs through which the compressed air passed to the accessories. A series of charts were shown furnishing in detail the average of air expended when the various appliances were in good condition. Our reproduction of these charts is self-explanatory and shows the minimum average and maximum rates of air consumption of all the auxiliary devices used on the several types of locomotives on which the tests were made. Chart No. 5 is a particulraly interesting as showing a combination of the data shown on Charts Nos 3 and 4. These values were found from the test data by dividing the total amount of air used during the trip by the total time of the trip in minutes. Chart No. 9 shows the cost per year, based on a working time of 6 hours per day and the price of coal at $2 per ton. The conclusions of the committee conveyed the statements that auxiliary devices used too much air; conditions frequently exist where compressor capacity may be exceeded by the auxiliary devices. Some of the data justifies the idea that the auxiliary devices should be operated separately from the air brake system. On the other hand, some of the data shows that with proper maintenance this conclusion might not be warranted; under some conditions it would not be satisfactory to connect the auxiliary devices to the air brake system and increase the compressor capacity, unless the air brake main reservoir is protected from the consequences of excessive air requirement by the auxiliary devices; cost basis show that better maintenance would be profitable; standards of performance, including maximum permissable leakage, should be established upon which to condemn devices unfit for service.



Among the recommendations suggested were that the work of the committee should be continued; that the investigations be extended; that better maintenance of the auxiliary devices be established; that the plan of operating the devices at a lower pressure than that of the air brake system be considered. This would save the amount of air used, but would require a separate compressor. The committee was continued.

M. C. B. AIR BRAKE DEFECT CARD.

Before resuming reports of committees in the second day's session, F. W. Brazier, superintendent of rolling stock, New York Central, was introduced and warmly commended the work of the association. Whatever was not satisfactory he laid at the door of the operating officials. The air brake force was insufficient to keep the appliances in the best condition. Mr. Brazier said that he had now 800 men working on the inspection and repair of air brakes, and he could use more. The repairs on freight cars cost twice as much as the repairs on locomotives, and it was remarkable that the work was as well done as it was. The future, however, was full of encouragement.

James Elder, chairman of the committee as above noted, presented the report and took sharp exception both to the design and use of the defect card. It was neither properly understood or supervised. On some roads its use might better be discontinued. It should be simplified, and its uniform use made obligatory. Its justification is to indicate existing air brake defects, so as to facilitate repairs, and as soon as the repairs are made it has served its purpose. The stub should be omitted Even if it were possible to get them filled out, they would burden the mails. Their purpose was impossible without more help. The present card, 3¼ ins. by 6¼ ins., should be reduced. Mr. Elder proposed 4 ins. by 2¼ ins. It would cost less and would not be so easily whipped away. The words "defective brake" was enough. The name of the road may be shown last. It is plainly undesirable to elaborate the card, specifying the various points where defects commonly develop. Effect, cause and remedy will be obvious at the next test.

The report created considerable discussion, and the subject was disposed of by recommending that the use of the card be restricted entirely to men in train service and inspectors in departure yards, and that the form of card recommended in the report be adopted.

FREIGHT CAR BRAKE MAINTENANCE.

Mark Purcell reported on behalf of the

committee having in charge the instructions on the above subject. The association had made a beginning in the matter of instructions, but they were not complete for the man working on the car, and contain matter that does not concern him. Some of the association's experts had prepared more complete instructions, and have since revised them several times. The result of the work was recommended to be submitted to the mechanical section of the American Railroad Association. Regarding the re-application of brake cylinder pistons without the use of lubricant, it is necessary to retain the filler to preserve the leather, but no available lubricant is a filler. Lubricants should be used sparingly to avoid using light oils for cleaning which has a bad effect in destroying the tightness of the packing. From the opinion of the best experienced men it would appear that what is needed in the brake cylinder is not so much lubrication as a method of treatment that will preserve the cylinder walls in their original clean and smooth condition, there not being any need of a lubricant in the brake cylinder when the movement and friction are so limited. Rusting should in some way be prevented. The real need is to keep the cylinder clean. Secretary Nellis suggested that the completed instructions be indorsed by the association and published in the proposed book of instructions. The suggestion was agreed to and also that the pounds per minute leakage be the maximum permissible under any condition, or after any time except at the time of cleaning, at which it shall be not be greater than five pounds.

The question of drafting resolutions expressive of the profound sorrow of the members at the loss to the association by the death of Walter V. Turner was brought up, and suitable action was taken to place on record the feelings of the members in regard to the irreparable loss.

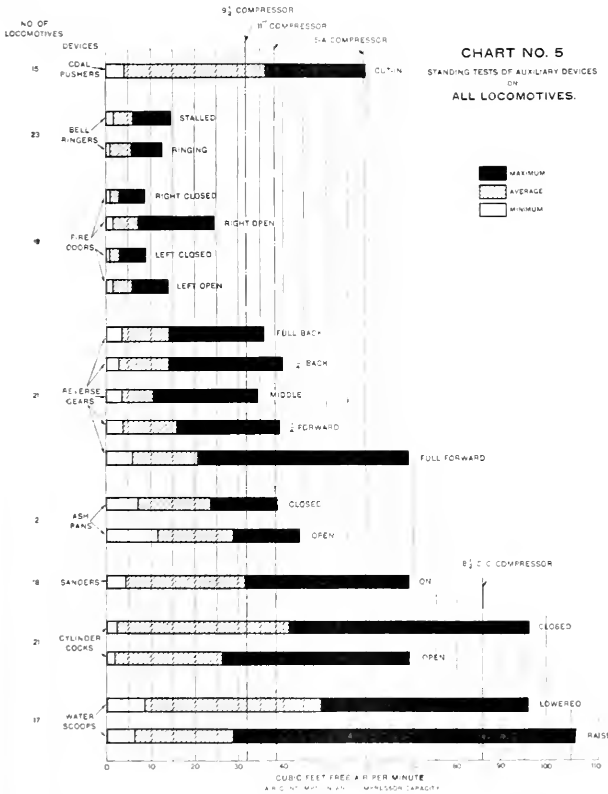


CHART NO. 5

STANDING TESTS OF AUXILIARY DEVICES ON ALL LOCOMOTIVES.

HOLDING STANDING FREIGHT TRAINS AND CARS ON GRADES.

R. J. Watters, assistant air brake inspector of the Northern Pacific, read a report on the above subject which dwelt forcibly on the importance of testing the capacity of the hand-set brakes to hold a train on a grade by releasing the automatic brakes momentarily before cutting off the locomotive. Several wrecks had occured through neglecting this precaution. After submitting a number of axioms as a precautionary guide to safe practice in the matter of holding trains on a grade under various conditions the report embodied the following general instructions and recommendations applicable to emergencies arising on grades:

"As soon as stopped on a grade, release and recharge at once. If the engine from which brakes are being operated remains attached, and keeps train charged, as it then should, hold with the independent brakes; that is, keep the independent or the straight air brake valve, whichever had, in application position. An exception is where the engineer is to leave the engine. In this case apply enough hand brakes to alone hold the train. Prove it by having all automatic and independent brakes off and, if compressor may be kept running, then re-apply the independent brake and leave its brake valve handle in application position.

"If the engine from which the train brakes are being operated is to be cut off, apply enough hand brakes to alone hold the train, but do not commence to apply them until the automatic brakes are released. Where retaining valves are in use, none need be turned down, but apply no hand brakes until one minute after train brake release is begun.

"Hand brakes used to hold cars or a train on a grade should be applied at the down-grade or lower end, thereby assuring against any car starting if uncoupled. All slack should be in, thus against the applied hand brakes, as well as all automatic brakes off (see previous exception about retaining valves) before cutting off an engine.

"If, with the engine in control of train cut off, another engine is to be detached, as a helper or pusher, its engineer should first cut in, release and recharge the train brakes, then release its independent brake so as to be certain the train will stand after he is cut off. While remaining with the train the independent brake should be kept applied on each of any such other engines.

"With a descending train, the 'final reduction' to bunch the slack as the stop is being 'completed, should be followed, during the wait of one minute after release is begun before commencing to apply hand brakes (at the head end), by reversing and pushing the slack in as much as possible, then holding the braking ratio about 40 per cent and to add a release valve located convenient for operation from the floor to cupola of the caboose. The release valve adjacent to the auxiliary reservoir is retained by suitable piping from this reservoir providing for bleeding it with either valve. It was held that any good argument for a different braking ratio than 40 per cent would favor a less ratio rather than a higher, as it is obvious that the caboose should not be braked much higher than a freight car when loaded. The inside

release valve, it was stated, not only provides against damaging wheels by sliding, but is very useful in certain daily switching operations.

"With an ascending train, slack in before cutting off should be insured by, with train brakes off, allowing it to drop gradually until train will stand with no aid from the engine in control. It should be held by hand brakes applied at the rear, aided by the independent brake of each other engine in the train.

"If a break-in-two, or burst hose occurs on a grade immediately apply *more than enough* hand brakes to alone hold the train until its brakes are again recharged. If it is a descending train, and a coupling is damaged that will take some time to repair, and if the portion of the train with the engine (ahead) can be backed so as to couple the detached hose, do so and keep the train recharged during any necessary wait while obtaining a repair part, as a knuckle or pin, or if a delay must ensue before putting the damaged car elsewhere, as where this occurs where the car may be switched out or to the rear end.

"See that the air brakes are off before applying hand brakes on cars set out on a grade, and on level track as well, sufficient to hold them. It is not necessary to bleed the air from auxiliary reservoirs of cars so set out as long as the air brakes are off when the hand brakes are applied. In addition to the foregoing comply with any rules regarding blocking cars.

"Hand brakes applied when the car air brakes are set, may result in broken chains when the air brakes leak off, especially dangerous with one or two cars. Even where this exceptional failure does not occur, they will often be so difficult to release as to necessitate the delay and waste of air required to apply the air brakes to aid in releasing them."

In the discussion that followed the reading of the committee's report, a strong feeling of approval was generally manifested and the suggestions were practically adopted.

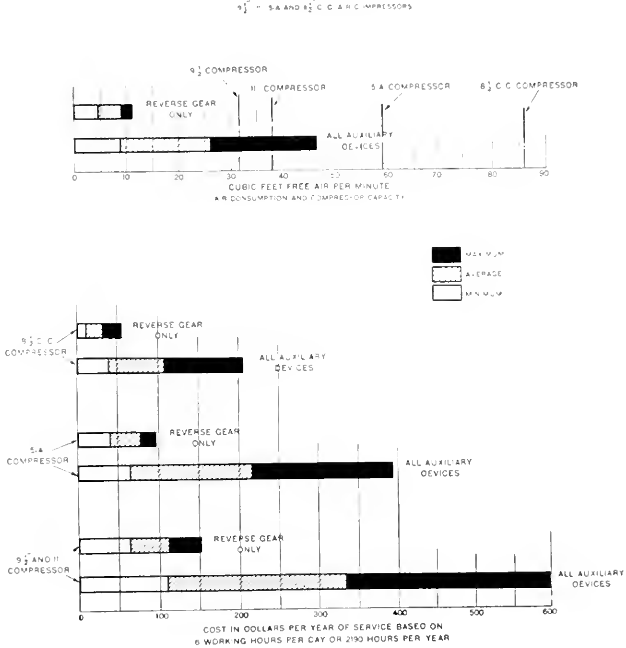
DAMAGE TO AIR BRAKE EQUIPMENT IN CAR THAWING PLANTS.

The Northwest Air Brake Club submitted a paper relating to the practice of subjecting carloads of frozen coal and ore to extreme temperatures, and the attempts to thaw them out for dumping. It had proved in many instances to be a source of damage to the packing leathers in air brake cylinders and triple valves which had frequently had to be removed for repairs. Thawing out by means of steam jets is better than the use of those plants where the entire train of cars is housed in a temperature as high as 250 degrees. In the discussion arising from the reading of the paper, the statements were substantiated, and measures looking towards the general use of thawing by steam jets were approved.

CHART NO. 9

COST DATA

BASED ON RUNNING TESTS



HOW CAN ENGINE AND TRAINMEN ASSIST IN AIR BRAKE MAINTENANCE?

H. A. Glick, air brake inspector of the Bangor & Aroostok, read a paper on the above subject, and offered many suggestions in regard to the specific duties of the trainmen in thoroughly inspecting the various appliances before starting a train of cars. The responsibility rests on the conductor to see that the general instructions are carried out, and if the trainmen do not follow these, they should be made to do so by proper measures. Trainmen should cease from the bad practices which contribute to brake pipe leakage; air brake hose should be separated by hand and not pulled apart, as pulling hose apart produces spreading of coupling jaws, destroys gaskets and creates porous hose. In separating cars, both angle cocks should be closed, as the leaving of one angle cock open allows the cars back of the separation to apply in emergency, which may allow emergency valves being held off their seat, causing a continuous blow.

AIR LEAKAGE THROUGH OUT-OF-GAUGE HOSE COUPLINGS.

The Manhattan Air Brake Club submitted a paper embodying the observations of its members in estimating the losses through improperly gauged hose couplings. From reliable sources it appears that 35 per cent of the leakage occured through this source in a certain train line amounting to 1,600 cars. It was found from actual tests that very few of the couplings would pass the Master Car Builders' gauging test, generally the result of ordinary wear on the couplings arising from distortions mostly owing to hammering in an effort to check leakage. The Manhatta Club concluded that such conditions were of sufficient importance to insist on the universal practice of gauging air brake hose couplings, and that this be included in the general inspection of air brake equipment.

A RESUME OF THE AIR BRAKE SUPERVISOR'S RESPONSIBILITIES TO THE STORES DEPARTMENT.

W. H. Clegg, air brake supervisor, Canadian National, presented a report on behalf of the Montreal Railway Club, and referred to the practice of holding a locomotive or car out of service while waiting for certain parts necessary for repairs. The lack of knowledge of forethought of the local officers was the cause of this. It should not be amended; it should be abolished altogether. This was possible because at less important stations there was evidently more forethought, and repair parts were always on hand. The supervisor should provide suitable places for the care and preservation of repair parts and have them always in stock; advice should be given in advance as to what should be carried in stock at the general stores; approval promptly of sub-requisitions placed with general stores; period-

ical inspections of divisional stores and assistance to general storekeepers; also preventing the accumulation of a surplus stock of repair parts that are seldom called for, besides advising the general storekeeper where a surplus of repair parts that are not needed so that they may be transferred to other terminals or to the general stores. None of these suggestions would occupy much time if acted upon promptly, but would save much time in handling traffic and keeping trains moving.

ADDRESSES BY LEADING RAILROAD MEN.

During the closing session, L. R. Pyle and F. P. Roesch, fuel supervisors of the Central Western and Northwestern Regional Districts, respectively, made able addresses emphasizing many of the recommendations made during the sessions of the convention, and alluded to the fact that a marked improvement had been shown during the war period in the degree of earnestness with which the air brake men had endeavored to do their share of the great work in which they were engaged. Mr. Pyle pointed out that this was particularly the case since the Air Brake Association had called attention to the magnitude of the waste of fuel on account of air brake leaks. Mr. Roesch spoke forcibly on the necessity of maintaining a high standard of efficiency, as it was the only method of maintaining a high standard of wages, because the best work had its reflex in a greater economy and made good wages possible.

ELECTION OF OFFICERS.

The following officers were elected: President, T. F. Lyons, New York Central; first vice-president, L. P. Streeter, Illinois Central; second vice-president, Mark Purcell, Northern Pacific; third vice-president, G. H. Wood, Atchison, Topeka & Santa Fe; secretary, F. M. Nellis, Westinghouse Air Brake Company, and treasurer, Otto Best, Nathan Manufacturing Company. Newly elected members to the executive committee are C. M. Kidd, Norfolk & Western; R. C. Burns, Pennsylvania; H. A. Clark, Soo Line, and H. A. Sandhas, Central of New Jersey.

Air Brake Appliance Association

In connection with the Air Brake Association's convention this year, and with a view to establish a systematic supervision of exhibits at future conventions, an organization of manufacturers of air brake appliances was formed at a meeting in Chicago, on May 7, to be known as the Air Brake Appliance Association. A constitution and by-laws were adopted and the following were elected officers: Chairman, J. J. Cizek, the Leslie Company; secretary-treasurer, F. W. Venton, Crane Company. Members of the executive committee for three years: J. F. Gettrust, Ashton Valve Company; J. C. Younglove, H. W. Johns-Manville Company; J. D. Wright, Westinghouse Air Brake Company. Members of the committee for two years: F. W. Venton, Crane Company; J. H. Dennis, New York & New Jersey Lubricant Company; L. H. Snyder, Joseph Dixon Crucible Company. Members of the executive committee for one year: J. J. Cizek, The Leslie Company; M. S. Brewster, U. S. Metallic Packing Company; D. S. Prosser, U. S. Rubber Company.

Among the companies having special exhibits at the air brake convention this year were the Anchor Packing Company, Chicago, Ill.; Ashton Valve Company, Boston, Mass.; Barco Manufacturing Company; Chicago, Ill.; Broschart Threadless Pipe Coupling Company, Trenton, Mo.; Chicago Railway Equipment Company, Chicago, Ill.; Detroit Lubricator Company, Detroit, Mich.; Dixon Crucible Company, Joseph, Jersey City, N. J.; Edna Brass Manufacturing Company, Cincinnati, Ohio; Garlock Packing Company, Palmyra, N. Y.; Gould Coupler Company, New York; Johns-Manville Company, H. W., New York; Leslie Company, The, Lyndhurst, N. J.; Nathan Manufacturing Company, New York; New York and New Jersey Lubricant Company, New York; New York Belting & Packing Company, New York; Ohio Injector Company, Chicago, Ill.; Simmons-Boardman Publishing Company, New York; Traction Lubricating Company, Chicago, Ill.; U. S. Metallic Packing Company, Philadelphia, Pa.; United States Rubber Company, New York, and the Westinghouse Air Brake Company, Pittsburgh, Pa.

Fuel Conservation Section of the United States Railroad Administration Tests of Locomotives for Fuel Losses

The series of tests which have recently been made under the direction of the Fuel Conservation Section of the United States Railroad Administration, and which are being published in circular form from time to time are of real value as showing the necessity of not only maintaining the locomotives in operation in the nearest approach to perfect condition in point of repair, but also of a strict maintenance of the standardization of all parts that have been particularly specified in the standards of construction. The effect on the depreciated efficiency of the locomotives in a poor state of repair is particularly to be noted in its effect on fuel consumption as well as in tractive efforts.

Superheater Fuel Losses

The fuel losses caused by stopped-up superheater flues reducing the efficiency of the superheater were shown by repeated tests on a consolidation locomotive with all superheater flues open and with different numbers of flues stopped up. The following are the general data concerning the locomotive tested with the appended summary of results tabulated from the tests:

Cylinders, 25 ins. by 30 ins.; diameter of drivers, 63 ins.; weight on drivers, 199,500 lbs.; values, 12 in. piston, maximum travel, 6 ins.; boiler, extended wagon top; tubes, 250, size 2 ins. diameter, 15 ft. 6 ins. long; superheater flues, 36, size 5⅜ ins. diameter, 15 ft. 6 ins. long; grate area, 52.75 sq. ft.; heating surface tubes, 2,813 sq. ft.; heating surface, firebox, 187 sq. ft.; heating surface, superheater, equivalent, 927 sq. ft.; heating surface, total, 3,927 sq. ft.; boiler pressure, 170 lbs.; tractive effort, 43,000 lbs.; ratio, heating surface to cylinder volume, 230.5. Equipment, Franklin butterfly fire door and five-course brick arch, supported on 4 arch tubes.

SUMMARY OF RESULTS.

Number of superheater flues stopped up	Average temperature of steam (deg. F.)	Drop in temperature below 586° F. (deg. F.)	Superheat (deg. F.)	Fuel loss (per cent)
None	586	..	211	....
5 to 7	576	10	201	0.04 to 2.6
8 and 9	549	37	174	6.0 to 9.6
12	517	69	142	13.2 to 14.6
18	491	95	116	21.0 to 24.2

The average gross weight of train for nine test trips was 2,270 tons, and the average number of cars per train 76.

The small fuel loss shown with but 5 to 7 flues stopped up was very largely due to the large size of superheater employed, the ratio of heating surface to cylinder volume being relatively large.

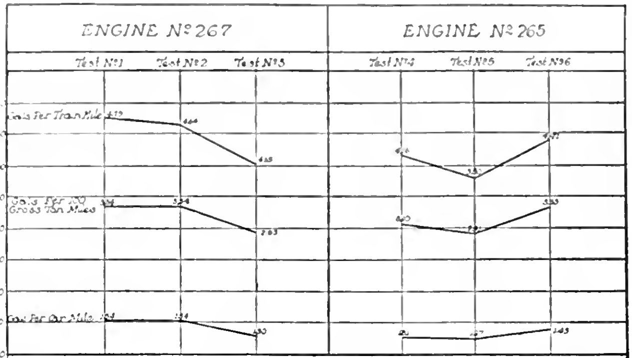
These tests show a fuel loss of approximately 2.5 per cent for each drop of 10 degrees F. in superheat temperature. They show clearly that in order to secure a proper return on the superheater investment the flues must be kept open; also, all

joints must be kept absolutely tight, which condition can be determined only by frequent hydrostatic test; the boiler must be kept clean, and a proper water level must be maintained by the engineer in charge. Without proper maintenance and handling, the value of the superheater is largely nullified.

Fuel Losses Due to Improper Locomotive Front End Conditions.

A special circular was issued some months ago outlining the fuel losses caused by choked exhaust nozzles and air leaks in locomotive front ends. In order to determine the actual fuel losses due to these causes, and also due to improper adjustment of diaphragms and superheater dampers, the tests reported below were made with a light Mikado locomotive equipped with a superheater, the cylinders being 26 ins. by 30 ins.; diameter of drivers, 63 ins.; tractive effort, 54,720 lbs.; steam pressure, 200 lbs.

The tests were made over a double-track freight division, 91 miles in length, with a maximum grade of 0.67 per cent. The locomotive tested was selected at random from regular freight service and operated throughout the test by the same engine crew. Readings were made of the draft in the front end, both in front of and behind the diaphragm, and in the firebox and ashpan. Superheat temperature was taken by pyrometer readings. Indicator diagrams were taken from the cylinders at varying speeds and lengths of cut-off. The drawbar pull was recorded by a dynamometer, and the tonnage equated on a basis of train resistance. Coal was weighed on scales, and the amount used while standing on sidings and at terminals was excluded from the results.



RELATIVE EFFICIENCY

Test	Condition of Valves	Train Mile Basis	Test	Condition of Valve	Train Mile Basis
Nº 1	R Valve out badly	84.7 Per Cent	Nº 4	Right Valve out	91.6 Per Cent
Nº 2	Both Valves out	87.3 Per Cent	Nº 5	Valves square	100.0 Per Cent
Nº 3	Valves square	100.0 Per Cent	Nº 6	Both Valves out in cut off	84.9 Per Cent

SUMMARY OF RESULTS.

NOTE.—Odd numbered test westbound, even numbered eastbound.

	Test No. 1.	Test No. 3.	Test No. 5.	Test No. 1½.	Test No. 5½.	Test No. 2.	Test No. 4.	Test No. 6.
Diameter of nozzle (inches)	5½	5⅝	5¾	5½	5¾	5½	5⅝	5¾
Height of draft plate (inches)	9¾	18	18	9¾	18	9¾	18	9¾
Miles run	91.8	91.8	91.8	43.0	43.0	89.9	89.9	89.9
Weight of train (tons)	2,149	2,326	2,245	2,207	2,302	3,056	3,037	3,070
Total 1,000 gross ton-miles	197	213	206	94.9	99.0	275	273	276
Coal consumed (pounds)	23,998	18,612	20,274	12,934	11,142	20,588	16,901	17,530
Coal per 1,000 G. T. M. (pounds)	121.8	87.4	98.4	136.3	112.5	74.8	61.9	63.6
Efficiency of locomotive on a fuel basis (per cent)	71.7	100	88.8	82.5	100	82.7	100	97.3
Efficiency of locomotive on I. H. P. basis (per cent)	91.2	95.3	100	91.2	100	90.5	93.7	100
Decrease in coal per 1,000 G. T. M.:								
Compared with Test No. 1 (per cent)	..	..	18.2	..	..	..	..	..
Compared with Test No. 1½ (per cent)	..	..	..	..	17.5	..	..	..
Compared with Test No. 2 (per cent)	..	..	..	..	..	..	17.2	15.0
Quality of coal	Good.	Good.	Fair.	Good.	Good.	Good.	Good.	Fair.

In the conduct of the tests outlined above, the following conditions obtained:

Test No. 1.—Locomotive as found in service with nozzle bushed to overcome air leaks around outside steam pipes. Diaphragm, 9¾ inches above bottom of smoke box. Diameter of exhaust nozzle, 5½ inches. Coal good, mine run.

Test No. 3.—Air leaks stopped by packing, nozzle bored to 5⅝ inches, and diaphragm raised to 18 inches. Coal good, mine run.

Test No. 5.—Air leaks stopped by welding No. 10 gauge sheet-iron plate over openings. Nozzle bored to 5¾ inches; diaphragm, 18 inches. Coal good, mine run, to point 43 miles west where tank of slacked storage coal of less heat value was taken, and this coal fired for remainder of trip.

Test No. 1½.—Locomotive as found. This part of Test No. 1 shown to compare with same part of Test No. 5 in order to determine influence of slack coal. Test No. 5½ taken as 100 per cent.

Test No. 5½.—Shown to compare with same part of Test No. 1, account all slack coal for remainder of this trip. Coal taken at intermediate point 46.9 miles from terminal.

Test No. 2.—Locomotive as found in service, but air leaks stopped by packing. Nozzle, 5½ inches.

Test No. 4.—Air leaks stopped by packing. Nozzle bored to 5⅝ inches.

Test No. 6.—Air leaks sealed with plate. Nozzle, 5¾ inches, but diaphragm run as originally found, viz, 9¾ inches above smoke box. This maladjustment of diaphragm resulted in an increase in fuel consumption per 1,000 G. T. M. of 3 per cent.

The results shown by these tests show conclusively the extraordinary possibilities in the direction of fuel saving that can be made possible by:

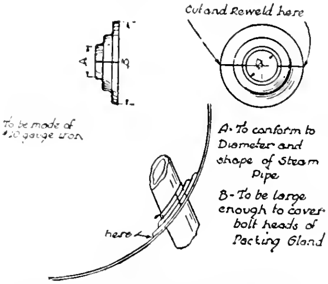
(a) The positive stopping of all front end air leaks, those that surround the steam pipes where these pipes pass through the locomotive front end being the most serious. The accompanying sketch outlines a simple and effective way for curing air leaks surrounding steam pipes.

(b) By establishing a standard front end adjustment for each type of locomotive, which, when arrived at, should be maintained and not moved around spasmodically by roundhouse laborers, boiler washers, or boiler makers, for the purpose of answering steam complaints that should be cured by a determination of the real causes followed by applying the proper remedy. The superintendent of motive power, who will order diaphragm plates, placed permanently in position by riveting, will have taken a positive, corrective, forward step.

(c) By the issuance of instructions calling for a summary of locomotive front ends to be completed within 30 days, a complete schedule of the changes made to be reported to chief motive power officer.

Fuel Losses Due to Defective Valve Motion.

A fourth series of tests for the purpose of determining the fuel losses sustained by



DETAILS OF JOINT TO PREVENT AIR LEAKAGE IN OUTSIDE STEAM PIPES.

reason of improper steam distribution in locomotive cylinders, occasioned by the inadequate maintenance of valve gear, or the careless adjustment of the same, were conducted in March and April of the present year, on two locomotives operating in passenger service. The major purpose of the test was to determine the extent of the fuel losses suffered, the efficiency of the locomotive not being impaired, however, to the extent that the train movement was delayed, or that any general complaints might be made as to the condition of the locomotive.

The weight on drivers was 91,675 lbs.; total weight of engine, 137,425 lbs.; tractive effort, 21,240 lbs.; valves, piston type cylinders, 20 ins. by 24 ins.; diameter of drivers, 73 ins.; boiler pressure, 190 lbs.; fuel, fuel oil, gravity, degree (Baumé), 26.8; diameter of exhaust nozzle, Engine No. 267, 4¾ ins.; Engine No. 265, 4⅜ ins.

In selecting the location for making the test, consideration was given to the following points: uniform weather conditions, regular engine crews throughout the tests, relatively uniform load and service demand, oil fuel, insuring measurement of amount and quality of fuel.

SUMMARY OF RESULTS.

CONSOLIDATED RESUME OF TESTS 1 TO 6. Twenty-one Round Trips Run a Division, 61.6 Miles Long.

	Engine No. 267.			Engine No. 265.		
	Test No. 1.	Test No. 2.	Test No. 3.	Test No. 4.	Test No. 5.	Test No. 6.
Total miles run	492.8	123.2	492.8	492.8	492.8	492.8
Average number cars in train	3.12	3.00	3.12	3.25	3.00	3.13
Average weight of train in tons	144	138	144	139	131	134
Total gallons fuel oil used	2,362	572	1,996	2,046	1,875	2,207
Gallons oil used per train-mile	4.79	4.64	4.05	4.16	3.80	4.47
Gallons oil used per car-mile	1.54	1.54	1.30	1.31	1.27	1.43
Gallons oil used per 100 gross ton-miles	3.34	3.34	2.93	3.10	2.91	3.35
Water evaporated, pounds	187,008	44,982	167,433	168,474	160,560	175,771
Average steam pressure, pounds	187	187	185	180	180	180
Total time on road, hours and minutes	15 h. 45 m.	3 h. 48 m.	15 h. 23 m.	15 h. 44 m.	15 h. 43 m.	15 h. 21 m.
Actual running time, hours and minutes	8 h. 23 m.	2 h. 8 m.	8 h. 35 m.	8 h. 25 m.	7 h. 44 m.	7 h. 26 m.
Number of stops	89	22	83	95	104	101
Number of slow-downs	81	17	82	70	91	86
Rates of fuel consumption (train-mile basis), per cent	118.4	114.5	100.0	109.4	100.0	117.6
Rates of fuel consumption (car-mile basis), per cent	118.4	118.4	100.0	103.0	100.0	112.6
Rates of fuel consumption (ton-mile basis), per cent	113.9	113.9	100.0	106.1	100.0	114.4
Per cent of efficiency, mean of car- and ton-mile basis	87.8	87.8	100.0	97.0	100.0	88.1
Per cent of efficiency, train-mile basis	84.5	87.3	100.0	91.6	100.0	84.9

CONDITIONS SURROUNDING TESTS ONE TO SIX, INCLUSIVE, WITH CUT-OFF AT NORMAL SIX-INCH PISTON TRAVEL.

Test 1, Engine No. 267—Right valve out, cut-off; right side, front 5 1/16 inches, back 10 3/16 inches; left side, front 7¼ inches, back 7¾ inches.

Test 2, Engine No. 267—Both valves out, cut-off; right side, front 7 1/16 inches, back 5 1/16 inches; left side, front 7 1/16 inches, back 5 3/16 inches.

Test 3, Engine No. 267—Both valves square.

Test 4, Engine No. 265—Right valve out, cut-off; right side, front 8½ inches, back 3½ inches; left side, front 6½ inches, back 6 13/16 inches.

Test 5, Engine No. 265—Both valves square.

Test 6, Engine No. 265—Both valves out, cut-off; right side, front 3 11/16 inches, back 8 7/16 inches; left side, front 4⅛ inches, back 7 13/16 inches.

NOTE.—The ratio of fuel consumption and ratio of efficiency on train-mile basis, representing as they do the combined weight of train and locomotive, express the relative amounts of fuel used with reasonable accuracy; the car-mile and gross ton-mile basis, not including the losses sustained in moving the locomotive, which, counting internal friction, equaled approximately 80 per cent of the weight of the train, do not wholly express the losses suffered as shown by Tests 1, 2, 4, and 6.

From the results shown it may be stated:

(a) That the condition of the valve motion vitally affects fuel consumption.

(b) That a locomotive may sound reasonably square yet be suffering from an improper distribution of the steam used.

(c) That irregular steam distribution makes the proper adjustment of draft apparatus impossible, with the result that the exhaust nozzle is choked to make the volume of steam required, not only increasing the fuel consumption but reducing the tractive power of the locomotive as well.

(d) That distorted steam distribution interferes with the proper lubrication of valves and cylinder walls and creates excessive back pressure, putting undue strain on piston rods, crosshead bearings and connections, main and side rods, crank pins, driving boxes and wedges, and is very frequently responsible for broken main frames.

(e) That excessive compression pressure, induced by distorted steam distribution, is largely responsible for cylinder head, steam chest cover and piston rod packing leaks.

(f) That the United States Railroad Administration and the officials responsible for the condition of valve motion can not afford to operate locomotives whose valve gear is not in condition to effect a proper distribution of the steam required to move the engine and train, entailing a waste of fuel ranging from 9.4 to 18.4 per cent.

The following immediate corrective measures are urgently recommended:

1. That where locomotive valve setting data has not been issued, immediate steps be taken to compile such to cover each class of locomotive employed; standard trains to be furnished each shop or roundhouse where valve setting is done; all tool rooms to be equipped with a master tram against which the service trains be frequently checked.

2. Start at once a valve squaring campaign of 30 days' duration, all locomotives whose valve motion is not in proven first-class condition to be gone over and adjusted to established standards.

The above tests and data relative thereto, and instructions appended, have been made under the supervision and by order of Eugene McAuliffe, manager, Fuel Conservation Section of the United States Railroad Administration, and it is expected that superintendents of motive power and others in authority in the mechanical departments will give the matters referred to their special personal attention.

Problems on the Design and Maintenance of Car Trucks

It will be generally admitted that the great war has sharpened the ingenuity of our railway men, and that they have not only handled the multiplex transportation problem admirably, but that their minds have run with mercurial swiftness into numerous channels of inquiry to which not much attention had been previously given. Among these the improvements in the design of car trucks is coming prominently forward, and it is peculiarly fitting that in view of the coming conventions of the railway mechanical associations that there is much to be expected in the way of advance in what may properly be called the reconstruction period of railway appliances generally looking towards a greater degree of efficiency and economy.

The subjects discussed at the railway clubs have been of unusual interest during the season just closing, and their contributions to the railway literature of our time have been both timely and valuable. As an illustration it is interesting to note that at the last meeting of the Canadian Railway Club an interesting paper was presented by W. J. Hyman, of the Grand Trunk Railway, in the course of which, in speaking of car trucks, he stated that, as is well known, "the wheel base of a truck is the distance between the centers of the outside wheels, on a six wheel truck, and, of course, the distance between the centers of a four wheel truck.

At present practically all freight cars in this company have the same length of wheel base under the different classes of cars. A 30-ton capacity car has a wheel base of 5 ft. 2 in. centers, a 40-ton car a wheel base of 5 ft. 4 in. centers, and a 50-ton car has 5 ft. 6 in. centers. As these three classes of cars are the standard freight cars of to-day I want to make a comparison of the wheel base of trucks under these cars and those of 40 years ago, to point out the difference between percentages of increase of car capacities and wheel base of trucks.

Standard freight cars, 1879—Average car, 40,000 lbs. capacity, 4 ft. 6 in. wheel base; large car, 60,000 lbs. capacity, 5 ft. wheel base. Standard freight cars, 1919—Average car, 80,000 lbs. capacity, 5 ft. 4 in. wheel base; large car, 100,000 lbs. capacity, 5 ft. 6 in. wheel base. Percentage of increase in load capacity of average car in 40 years, 100 per cent. Percentage of increase in wheel base of trucks of average car in 40 years, 18 per cent. Percentage of increase in capacity of large cars in 40 years, 60 per cent. Percentage of increase in wheel base of trucks of large cars in 40 years, 10 per cent.

You will therefore see that one of two things must have happened in regard to the wheel base of these trucks. Either the original design was ideal and needed little change, or because it was a standard 40 years ago, on account of trying to standardize as much as possible all material, the design has been perpetuated with little thought or study in regard to the changing conditions in capacity of equipment or roadbed. During this 40-year period great changes have taken place in the construction of the roadbed and contour of track rails and switches, which have all been standardized. The Master Car Builders' Association has done great work in the standardization of cars, and nearly all details which vitally affect the construction of cars have been made standard all over the continent, thus facilitating the interchange of cars on all railways.

As a lot of these standards, both for roadway and equipment, have a direct relation one with the other, especially in reference to contour of wheels and track rails, it would be practically impossible to change any of these designs without affecting the other and costing the railroads an enormous amount of money, and we therefore turn to truck wheel base to see if a change would be beneficial in the maintenance of roadway or the reduction of cost in repairs to cars.

On passenger cars we have an 8 ft. wheel base for 4-wheel trucks and 11 ft. for 6-wheel trucks, and have taken care of certain conditions with a flexible truck to make an easy riding car. Now on freight cars we have a short wheel base 4-wheel truck, and the accompanying Diagram No. 1 shows the turning moment for trucks of various wheel bases under a freight car at start of curve.

From the diagram it is quite evident that the longer the wheel base the less wear we would have on the ball of the rail at curves and tangents, thus reducing the cause of the removal of a large percentage of track rails at these points. It would also reduce the wear on the flange of the wheel, which is the cause of the removal of lots of wheels, and lessen the thrust on the collar of the journal with the resultant wear on ends of brasses, and this end thrust is thought by many to be the direct cause of the start of a large percentage of hot boxes, and anything which would reduce hot boxes would be welcomed by several departments of any railroad.

Another thing in favor of a longer wheel base is that the blow delivered on

the end of the rail at the joint would be reduced. Track rails are frequently removed because of the flowing of the end where one joint has become lower than the other, and the constant blows delivered by the wheels of the cars as they pass over the joint gradually cause the end of the rail to flatten out a flow. Diagram No. 2 shows the car wheel suspended before delivering hammer blow on the lower rail, the rear wheel being deflected an average of ¼ in., according to the ballasting.

It is impossible to figure out a formula to arrive at the blow delivered at these joints, owing to the fact that so many factors enter into the calculations which vary at every joint, especially in the ballasting of the road and the wheel base of the car itself, also the speed of the train and other causes; but one thing is certain and is proved by demonstrations of a practical kind made by the American Railway Engineering Association that in proportion as the wheel base of a car is lengthened up to a certain responsible point this blow is decreased and the life of the rail would be proportionately longer.

The impact from a flat spot under the modern heavy car is many times greater than the impact from the car of 1879, when the present limit was fixed, due to much higher speeds, and the fact that the maximum wheel load is now nearly four times heavier than in 1879. It is a fact that rails are broken by flat spots, though specific cases have been difficult to cite, because often, the rail, while badly damaged, may not break until some time after the passage of the flat wheel.

Ordinarily wheels having 2½ in. flat spots are removed from the axle and scrapped, whereas if the limit were fixed at 1½ in. it would be possible to reclaim such wheels and replace them in service by grinding out flat spots without removing the wheels from the axle and at a cost of about 50c a pair. Grinding is being done, with excellent results, by a number of roads, and it is recognized by authorities as good practice, provided, of course, that the wheel has not been burned during the process of flattening. Therefore a reduction of the allowable limit from 2½ in. to 1½ in. would not only lessen the impact and damage to the rail, but should prove economical from the standpoint of service life of wheels.

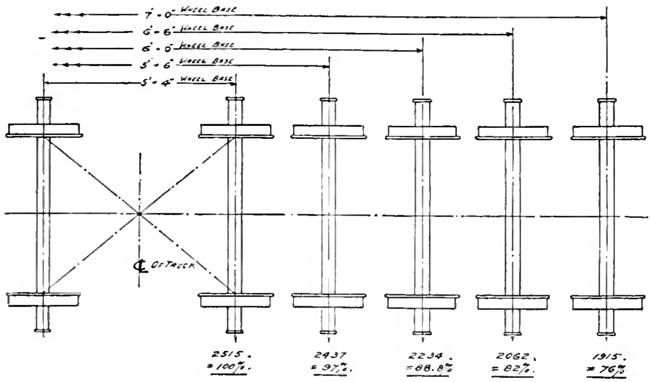


DIAGRAM NO. 1, SHOWING DIFFERENCE IN TURNING MOMENT AT START OF A 200 FT. CURVE FOR AN 80,000 LBS. FREIGHT TRUCK UNDER FULL LOAD AT 30 M. P. H., FIGURED ON VARIOUS WHEEL BASES.

Assuming a 33 in. wheel and 2½ in. flat spots, we determine that for the modern car, at average speeds, the factor of safety for a 100-lb. rail is about 5, but for the heaviest cars about 2.75. According to this formula the impact from a 2½ in. flat spot under the modern 50-ton gondola, at 45 miles an hour is about 10 times greater than the impact from the old standard 20-ton car at the then maximum speed of 20 miles an hour. It would therefore appear that flat spots should be reduced from 2½ in. to a maximum of 1½ in.

There is a lot of argument to-day in regard to the length, and the angle, at which brake head hangers should be hung, and we are told that flat spots on wheels are frequently caused on this account: and on our latest freight cars we are using longer hangers, and trying to remedy the bad effects caused by tilting of shoe through short hangers, and dragging of shoe on wheel; and on passenger tracks the clasp brake is a remedy for the ills of the old time brake gear, so this is one case where in passenger service an improvement is gradually taking place.

In summing up, therefore, it appears that a larger wheel base, say 6 ft. approximately for freight cars, would be an improvement over present standards, and a thorough study of the cause of flat spots on wheels should be made to eliminate this trouble and also a reduction made in maximum length from 2½ in. to 1½ in. on freight car wheels, and thereby contribute to the growing spirit of the needed economy in railway practice."

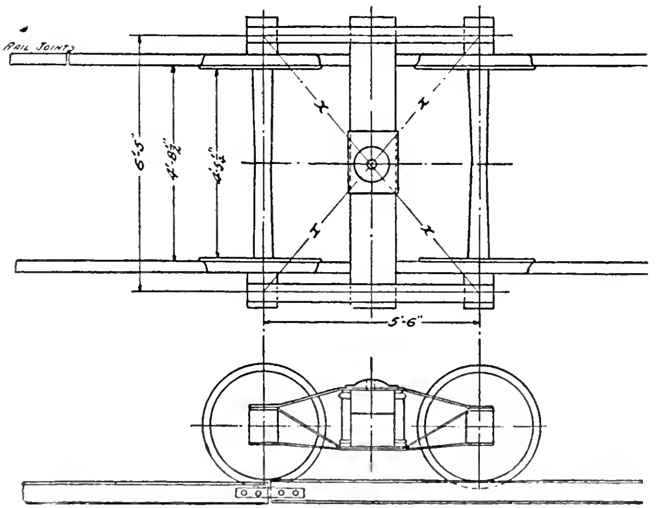


DIAGRAM NO. 2, SHOWING WHEEL SUSPENDED BEFORE DELIVERING HAMMER BLOW ON LOWER RAIL.

The Plastic Arc System of Welding

By J. O. Smith

The rapidly growing use of electricity as a means of the joining of metals, in repairing cracks or breaks, salvaging defective castings and for metal cutting purposes, all included under the general

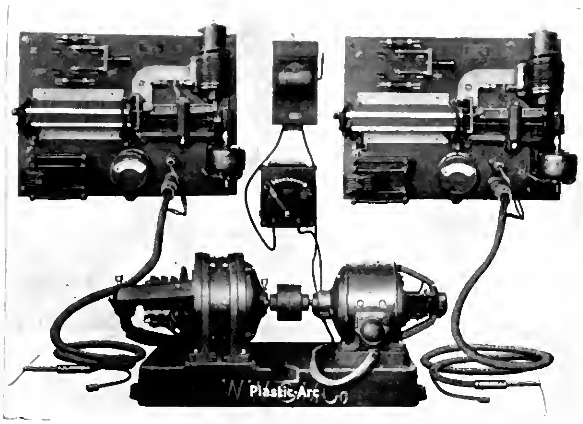


FIG. 1.—WILSON TYPE OF ARC WELDING OUTFIT.

head of electric welding, although comparatively simple in theory, has been slower in development in this particular field than in any other service in which it has been applied. This slow growth is probably due to two causes—the scarcity of skilled operators and reliable appar-

FIG. 2.—BOILER REPAIRING BY ARC WELDER.

atus suitable for performing the actual operation.

During the last two years, however, arc welding has made great strides, and undoubtedly a great stepping-stone, by means of which it has attained greater prominence and the confidence of the engineering world, was through the successful welding of the damaged parts of the interned German ships at New York at the outbreak of the war in the spring of 1917. It was then recognized beyond a doubt that electric welding could be depended upon to make permanent repairs, no matter how large or how bulky the part to be welded or the character of the metal.

There are four general fundamental types of arc welding outfits in general use at the present time—constant potential with fixed resistance; variable potential, rising and falling inversely as the current rises and falls; constant current, all employing direct current, and the alternating current type, with reactive control.

The constant potential system is the oldest of the direct-current systems. It was originally designed to work on a generator voltage of between 75 and 80 volts, but as later experiments and results clearly demonstrated that more satisfactory results could be obtained with a much lower voltage, this system has been redesigned to work on a generator voltage of 35, with 18 to 22 volts at the arc for actual welding. A distinct advantage of low voltage at the arc is that it becomes impossible for the operator to draw out a long arc between the electrode and the work. With a low-voltage supply the external appearance of a weld is a certain guide to its value, and it can be safely reckoned to be free internally from any dangerous slag or oxide inclusions.

Owing to the alterations of the current, it is practically impossible to draw a long arc in the alternating current system and further, owing to the arc being more sensitive in its length than in direct current systems, a higher voltage is necessary to steady it. Coated electrodes are used with the alternating system.

In the Wilson Plastic-Arc system, which was so successfully used in repairing the engines and other parts of the damaged German ships, which system comes in the constant potential class, the power lost in the line and in the automatic current regulation is of low value compared to the energy actually required for welding, and there is, consequently, a great saving over other systems employing high voltage. The low voltage used also insures better penetration of the original metal by the concentrated arc than is true when a longer, diffused arc of the higher voltage system is used. The arc itself is produced between the material to be worked, which is connected to the positive side of the circuit, and a rod, usually of the same material, which is connected to the negative side. This electrode of welding material is so proportioned that the amount of the elements burned out by the arc is compensated for. Thus the chemical resultant in the weld is predetermined.

In the accompanying illustrations, Fig. 1 shows a two-arc 300-ampere welder. This is the most recently improved of the Wilson System type of welder, which is in the constant potential class, and operates by means of a standard flat compound 35-volt generator to feed a special constant-current controller. The carbon

FIG. 3.—SHOWING A FILLER (B) INSERTED IN BROKEN LOCOMOTIVE FRAME.

pile and solenoid that operates the arc, are in series with it, so that the current through the arc is controlled by the automatic variation of the resistance of the carbon pile in response to the pull of the solenoid. The pull of the solenoid is balanced in turn by a spring connection

from a leverage, and the current adjustment is made by changing the leverage. The pilot motor, which is controlled by a switch at the welding-tool handle, regulates the lever so that the operator can change the current at the arc, if necessary.

Fig. 2 shows repairs being made by arc welding to a boiler, some of the rivets of which have failed, resulting in a leaky seam. An excellent example of welding where the service is severe is illustrated in Figs. 3 and 4, which show before and after welding views of the repair of a locomotive frame. The frame was broken at B, and in cutting out the defective part a large space was left between the two ends of the frame. The filler B is a new piece of metal set in and tacked with the welder and is ready for the completion of the job, which is shown in Fig. 4. The work required 41 pounds of electrodes, 125 to 150 amperes at 35 volts. The welding time for one welder was 30 hours, using in that time approximately 165 kilowatts of electrical energy.

Fig. 5 is an example of heavy repair work on a main driving wheel of a locomotive. This special repair has repeatedly been proved to be more durable than any other part of the repaired wheel. Fig. 6 establishes the fact that a great deal of time can be saved by using two welders at once on the same job. The illustration shows the filling in of a cast-steel engine crank preparatory to reboring.

In conclusion it may be added that welding, if properly done, can be applied to the largest kind of boiler work as was particularly demonstrated in the case of a boiler header that was welded recently by the Wilson system in Chicago. A pressure test was applied to the boiler to

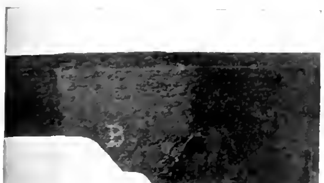


FIG. 4. SHOWING FRAME WITH ARC WELD COMPLETED.

determine its holding qualities. After the ordinary test pressure had been applied, a special pressure of 3,500 pounds per square inch was applied, and not a single defect, not even a pinhole, developed. The only outward evidence of the unusual pressure being applied was the bulging of the header. No machine could be procured around Chicago that could provide a higher pressure on the boiler and the tests were considered conclusive evidence of the holding qualities of the weld.

Railway Earnings in 1918.

The following is a summary of the earnings and expenses of the 195 railways,

FIG. 5.—HEAVY REPAIRS ON LOCOMOTIVE DRIVING WHEEL BY ARC WELDER.

Class 1, embracing 180 carriers and 15 switching and terminal companies, each having annual revenues of above $1,000,000, and compares the aggregates of 1918 with those of 1917:

Operating revenues for 1918 amounted to $4,913,319,604, an increase over 1917 of $862,856,025, or 21.3 per cent. Freight revenue increased 21.7 per cent., and passenger revenue 24.7 per cent. Operating expenses aggregated $4,006,894,762, which was an increase over 1917 of $1,148,682,552, or 40.2 per cent. Maintenance of way expenditures increased 46.7 per cent., maintenance of equipment 60.4 per cent., and transportation 33.7 per cent. The operating ratio was 81.55 per cent., as compared with 70.57 per cent. in 1917. Net operating revenue amounted to $906,424,842, a decrease of $285,826,527, or 24 per cent. Taxes were $186,652,095, an increase of 2.1 per cent. over 1917.

Net operating income amounted to $690,418,778, a decrease of $284,360,159, or 29.2 per cent., compared with 1917. The net operating income for 1917 was greater by about $70,000,000 than the annual average of the three years ended June 30, 1917, the test period which formed the basis of the standard return guaranteed to the roads by the Railroad Control Act of March 21, 1917. Accordingly, the point of greatest interest in connection with the net income earned in 1918 is not the $284,000,000 by which it fell below that for 1917, but the approximate difference of $214,000,000 between the $690,000,000 actually earned by roads of Class 1 under government operation during 1918 and the $904,000,000 which they earned annually during the test period.

Demand for Railroad Ties.

An increased number of railroad ties are being purchased by the Railroad Administration to supply the demand of the railroads. This new policy makes it easy for owners of wood lots to sell at a good profit ties cut from ordinarily inferior hardwoods. These ties are being made reasonably durable through preservative treatments. White or red oak, chestnut, ash, hickory, beech, birch, cherry, maple, elm or sycamore may all be sold at a profit if delivered at the railroad in accordance with specifications provided by the railroad company. Timber owners are urged to take advantage of this favorable increase in market conditions for native hardwoods.

Westinghouse Scholarships.

As a memorial to the more than 8,000 employees of the Westinghouse Electric & Manufacturing Company who entered the army in the great war, a number of technical scholarships have been established, the details of which have been given out by President E. M. Herr. The scholarships, of which there are four, are limited to sons of employees who have been in the company's service for five years. Two of the scholarships may be open to younger employees who may have been employed for a shorter period. The examination of candidates will take place annually, and the successful candidates will be entitled to pursue a four years'

FIG. 6.—SHOWING TWO OPERATORS AT WORK ON ENGINE CRANK.

course in any technical school or college that they may select. Each scholarship carries with it an annual payment of $500. The Memorial Scholarship Committee consists of three vice-presidents of the company, who will formulate rules and regulations regarding details.

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The Atlantic City Convention.

The mechanical convention at Atlantic City takes on an international aspect this year. In addition to the largest attendance of the leading railway men engaged in the mechanical departments of railways, there are assurances of the presence of foreign representatives who will have an opportunity of seeing the predominant characteristics that are making for railroad supremacy in America, and if they have eyes to see and heads to understand they will learn that the atmosphere of engineering enterprise and ingenuity is just as marked in the sunshine of peace as our triumphant armies have been in the shadow of battle.

Not only so, but the lapse that has occurred during the war period will give an added zest to the proceedings this year. The American people have become spiritually and intellectually quickened by reason of the menace to civilization, and none have felt the mighty influence more than the railroad men. The educational advantages of such a meeting cannot be overestimated, particularly to the young, and there are none too old to learn. In addition to these facts there is the high companionship of alert minds associated in a common cause, with the recreation that comes from a brief break in the monotony of any occupation however interesting in itself, giving the promise of a quickened spirit in the days that are to be.

Shop Management

The Federal and general managers of the Eastern Region have been furnished with a report of a committee recently appointed in their region, and assisted by a representation of the mechanical department of the United States Railroad Administration who have been making investigations in regard to the operation of railroad repair shops, the methods of supervision and the keeping of records. The findings of the committee, although not mandatory, are nevertheless believed to contain much that may be of value in simplifying and improving the methods now in vogue.

The subject of the number of men employed under one foreman or supervisor is particularly dwelt upon, with the statement that when the number exceeds 30, a lack of activity on the part of the workingmen was noticed. This, of course, refers particularly to men working on a day basis. Piece workers, apparently, keep at full speed under any condition. The foreman should also be relieved of clerical work, and meetings of foremen or supervisors should be held at other than working hours. There is no particular mention of any remuneration to the foremen for their attendance at such meetings. Presumably the committee looks upon these meetings as being all in the day's work.

Then the time clock should show the workmen's names, occupation and number. A one-week card is preferable. Clocks should be limited to 125 employees, opening their works at 15 minutes before starting time and closing with the last expiring shriek of the whistle. Then the clocks should open again at quitting time, and remain until the last man leaves, with an attendant during those busy periods.

In regard to the scheduling of work through the shop there should be a predetermined route and time limit. The locomotive should be thoroughly inspected before entering the shop, and a copy of the inspection report furnished to the man in charge of making out the schedule, who should furnish a variety of lesser reports to the various sections in the different classes of work, the various units of the locomotive not necessarily exceeding 30 in number, being properly classified, with the dates of dismantling and expected completion. Other spaces should be left for dates for machine, blacksmith and other work and the date of completion. Still other spaces should be left for remarks and cause of delay, if delay occurs.

Then there should be a daily schedule delay report, furnished by the schedule man to the officers in charge, this form to cover all locomotives on which any part is behind the schedule time. Then there should be a blackboard in each department where all can see what is expected in the way of repairs. This board should be checked with marks when the work is completed. This board will show where the delay, if any, occurs. As may be imagined, there is considerable clerical work in all this, and in addition to this, there are an endless variety of pattern numbers and other forms and blank spaces and duplicate slips, from which other clerical forces may compute the cost.

During the committee's investigation, it appears that out of ten shops visited, eight of them had the most of these regulations already in operation. Others were said to be catching up with the system as rapidly as they could, but in no particular case were the documents sufficiently complete to form an exact basis of the cost of repairs. The findings of the committee conveyed the idea that it would be impractical to endeavor to arrive at the cost of locomotive repairs from a description of the work as shown on the daily time card, that is, other than the locomotive as a whole, and not the cost of each particular unit of work, a practice which it is doubtful if the workmen would countenance.

Boiler Water Treatment.

As is well known, all natural waters contain more or less impurities partly as suspended matter such as clay, sand, insoluble forms of iron, aluminum and other minerals, etc., and partly as dissolved matter, such as compounds of calcium, magnesium, sodium, potassium and other mineral salts. Much of the suspended matter, as well as most of the dissolved matter, may form scale, but the suspended matter may generally be removed by filtration. The effect of an increasing deposit of scale on the passage of heat through the walls of a boiler tube is similar to the effect on the passage of water through a tube of continually decreasing bore. In the case of the water tube the only way to get a uniform volume of water through it in a given time, in spite of its diminishing bore, is continually to increase the pressure in the water; so in the case of a boiler tube covered with a dense scale the only way to maintain a constant flow of heat from the furnace to the boiler water is to increase the heat pressure so to speak; that is, to burn more fuel. The loss in any particular case could best be determined by comparing the fuel consumption with clean and then with scale covered tubes, other operating conditions being kept uniform.

The removal of scale-forming components from water by chemical means is accomplished by converting the calcium and magnesium compounds into practically insoluble forms, causing them to separate from the water and allowing the material to be removed by blowing down, filtering, or sometimes by settling. Lime and soda

ash are generally used for this purpose when the softening occurs before the water enters the boiler. The lime combines with the carbon dioxide which held the calcium and magnesium carbonates in solution. These are no longer soluble in the water after removing the carbon dioxide, and therefore separate from it. In a similar way the sulphate scale is removed by conversion to insoluble carbonate by the soda ash.

While preventing the formation of scale is advisable, there are methods and water-treating material used largely to remove scale already formed, and to some extent prevent the formation of new scale. Graphite and kerosene are frequently used for these purposes. Their action seems entirely mechanical. Expert opinions vary as to the desirability of their use, but the approval of practical men is general, but it cannot be too strongly emphasized that the question of water treatment is one in which the employment of competent chemical and engineering knowledge is both absolutely necessary and highly profitable, and it would be far wiser to omit all forms of water treatment (involving the use of chemicals) rather than to undertake such without knowing accurately the composition of the water and of the material used to soften it. It is most important to remember that the quality of the water, even when secured from the same source, varies widely from time to time. These variations are not only seasonal and monthly, but daily and even hourly. A condition of excessive concentration of the water after a protracted drought may be changed within an hour to a correspondingly excessive dilution by a summer storm. The result would be to decrease enormously the percentage of dissolved matter and to increase, probably to a much greater degree, the amount of suspended matter. As a consequence, a prescribed treatment of the water based on its analysis at any particular time might not lead to satisfactory results if applied at some other period.

Ms. Basford on Locomotive Reconstruction.

The burning question of the hour—coal saving—had a hearing at a recent meeting of the New York Railroad Club. M. A. Daly, fuel supervisor of the Northern Pacific Railroad, read an interesting paper showing the western methods of training firemen, many of which were excellent in their way, and the results have proven eminently satisfactory. Single scoop firing seemed to be the nearest approach to the locomotive stoker. Every fireman, the speaker said, has not the patience to work it out. It is the ideal to which firemen may aspire. Those who can approach it use less coal than formerly. Motion pictures, enabling firemen to see themselves as others see them, had raised the character of the service by inducing self-criticism. A series of pictures were shown, cleverly illustrating the paper.

In the course of the discussion that followed, George M. Basford, president of the Locomotive Feed Water Heating Company, pointed out that apart from the excellent suggestions made the fact remains that the best of coal and the best management of the fire may be nullified by the locomotive itself if the machine is not what it ought to be. What is wanted is to put the locomotive in shape for its various parts to pull together to use the coal to the best advantage. Boilers should not send wet steam to the cylinders. Fireboxes should not send unmixed and therefore unburned gases to the flues. Tender tanks should send water to the boiler unheated by waste heat. There are a lot of other ways in which many old engines are working against themselves for lack of modern means for conserving their facilities and abilities. Even the best of firing of itself cannot insure the proper development of the heat of the coal or its use in producing power. There are about 25,000 locomotives that as to power remain as they were built ten or more years ago. Unless these engines are brought up to date they are antiquated, obsolete and an encumbrance as to power and as to the waste of fuel. Many of these engines were ten or more years old when they were built. This was because of bridge or other weight limitations. What coal saving can you expect of men who know that the machine you give them wastes coal faster than they can save it?

In six years the coal consumption of locomotives has gone down from 3.6 lbs. per draw-bar horsepower to 2.25 lbs., the figures being taken at the most efficient power of the engine. No parallel improvement has ever been made in six years in any other branch of engineering development. This has been done by intelligent use of improved designs and by the employment of labor and fuel saving and capacity increasing factors which everybody knows about. These figures show what may be done and what is aimed at with new engines, but why overlook the 25,000 old ones? These improvements may be applied to old engines that are in shape to run at all, and they give these old engines increased power, making them, weight for weight, equal to the biggest, newest engines of the latest and best designs, and in many instances they will be better adapted for the work they are doing than new engines would be. The way to do it is to make a survey of the old equipment in complete detail, and determine the number of engines to be rejuvenated per month. One of the roads that did this found that the improvements paid for themselves in seven months. Every $100 of cost earned $171 in the first year. This was 171 per cent investment. If the engines had but one year of life ahead of them it would have paid handsomely. Does it not put in the shade all other locomotive economies that can be thought of? These old engines should be modernized or they should be scrapped, and that speedily. The question may be asked—where is the money? The money is blowing up the stack of every unmodernized engine. The entire first cost of modernizing is wasted in coal every seven to ten months on every one of those engines that is working. Did we back away from Germany because we did not have the money for the war? We got the money!

Other speakers warmly endorsed Mr. Basford's convincing arguments, and a wider disseminatoin of his logical conclusions in regard to the reconstruction of the older locomotives could not fail to have a marked effect in the conservation of fuel.

Employment for the Returning Soldiers.

It is a matter of pride and satisfaction to note that the returning soldiers are not only meeting with that enthusiastic warmth of reception from a grateful people to a heroic and triumphant army, but what is of more lasting value, thoroughly organized bodies are setting about securing employment for every man capable of again joining the ranks of industry. In this regard the railroads are in the front rank. With few exceptions almost every railroad company is finding room for their returned employees, and the general opinion is that the soldier is a better man than when he went away.

Discipline, self-reliance, the simple life, or, rather, the hard life, develop the heroic in men, and it is not too much to say that through the furnace fires of battling for the right, the American people will feel morally, intellectually and physically quickened. It is therefore a duty that we owe to the returned soldier to see that not only those who left steady employment to maintain civilization against a barbarous foe, but to that large class of young, intelligent and energetic men, many of them who had barely entered on the threshold of life, and consequently could not be expected to be highly skilled, that all should be furnished with opportunities for self-support and self-development which should be the first aim not only of a government by and for the people, but of the people themselves.

As for those whom we shall see no more, their heroic deaths have sealed the unwritten but unavoidable convenant of our common brotherhood. Their deaths have laid the enduring foundations of the hope of the civilized world for future peace.

Air Brake Department

Questions and Answers

Locomotive Air Brake Inspection

(*Continued from page 149, May, 1919.*)

774. Q.—What is wrong when the compressor does not draw in any air on the down stroke of the piston and the valves are in good condition?

A.—It indicates badly worn air piston packing rings.

775. Q.—How does this prevent the entrance of air on one stroke?

A.—Air pressure gets between the outside surface of the rings and the wall of the cylinder forcing a portion of the ring into the groove, and all of the air in one end of the cylinder passes the rings and fills the other side of the cylinder before any can be drawn in from the atmosphere.

776. Q.—When does this usually occur?

A.—At a time when but one-half of the cylinder is lubricated.

777. Q.—How does it happen that but a portion of the cylinder may be lubricated?

A.—By attempting to oil the cylinders when the air pressure is high and the piston speed very slow.

778. Q.—How should an air cylinder be lubricated with hand oilers?

A.—With very hot valve oil when the air pressure is low and the piston speed fast.

779. Q.—What causes receiving valves to become worn loose and roll about on the valve seats?

A.—It is the result of oiling the air cylinder through the strainer.

780. Q.—In what way?

A.—The oil admitted in this manner picks up dirt which lodges on the valve seats slightly cocking the valves from time to time until the wings and seats are badly worn.

781. Q.—What other damage results from oiling through the air strainer or from admitting oil in too large a quantity?

A.—It clogs up the ports and passages, results in overheating, and causes a carbon to form on the air piston and lower head that results in the air piston or steam piston in breaking off the rod.

782. Q.—What is the result when the taper fit is used between the air piston and rod?

A.—The steam piston is then generally pulled off the rod.

783. Q.—What is the principal cause of steam pistons pulling off the rods?

A.—Running the compressor too fast with a low air pressure in the main reservoir.

784. Q.—Has this ever been demonstrated by test?

A.—Yes, one of the air brake companies took a new compressor out of stock, run it with 200 lbs. steam pressure against 0 air pressure with a wide open throttle and at the end of 25 minutes' time the steam piston was torn off the rod.

785. Q.—How are leaky discharge valves detected in compressors?

A.—If leaking very badly or broken, the compressor piston will move very slowly toward the broken valve and swiftly away from it.

786. Q.—Does this hold good with cross compound and duplex compressors?

A.—Yes, by noting the movements of the pistons, a leaky discharge or intermediate valve is readily detected.

787. Q.—What should be done when a compressor is reported as not working?

A.—It should first be known that the steam cylinders are lubricated, and that the pump governor is not interfering with its operation.

788. Q.—How would it be ascertained if the governor was preventing the operation of the compressor?

A.—By noting whether there is a blow at the vent port of the governor, then slacking off the nut of the union connection next to the compressor to see that it is receiving an ample supply of steam.

789. Q.—What would likely be wrong if the compressor made several strokes and then gradually stopped, and a considerable amount of steam escaped when the reversing valve chamber cap or steam chest cap was removed?

A.—It would indicate that there was a stoppage in the exhaust pipe.

790. Q.—What should be done in an effort to locate the trouble, if the compressor will not start at all?

A.—Close the pump throttle tightly, shut off the lubricator and drain the air out of the main reservoir. Then watch the movement of the pistons when the pump throttle is opened quickly.

791. Q.—What would likely be wrong with the 9½-ins. or 11-ins. pumps if the piston then made an up-stroke and stopped?

A.—It would indicate broken or very badly leaking small main valve packing rings, or a piece of broken air valve between the air piston and center piece, or possibly a reversing valve plate bolt has worked out.

792. Q.—What might be wrong if the high pressure steam piston of the compound compressor made such a movement?

A.—The same identical obstructions or broken small main valve packing rings.

793. Q.—What could be wrong with the No. 5 or 6 compressors, if the low-pressure piston moved to the top end of its stroke and the high-pressure piston would not follow?

A.—It indicates the same obstructions in the cylinder or a broken valve stem on the low-pressure side.

794. Q.—What would likely be wrong if the low-pressure piston made the complete stroke and the high-pressure piston followed but both pistons remained at the top end of the stroke?

A.—It would indicate that the valve stem of the high-pressure side is broken, or that some obstruction, possibly a piece of broken piston, has lodged between the high pressure steam piston and center piece or that possibly a loose piston rod nut has prevented the high-pressure piston from making its full stroke.

795. Q.—What might be wrong with the 9½-ins. or 11-ins. pumps, if, under the same conditions, steam was quickly turned on and the piston made a complete reversal at the top end of the stroke and stopped at the bottom end of the cylinder?

A.—It would indicate that a piston rod nut had worked off, or that the reversing valve rod had broken off at the shoulder.

796. Q.—What might be wrong if the high-pressure steam piston of the 8½-ins. compressor made the same movement?

A.—It would indicate that the reversing valve rod had broken or that a low-pressure air piston rod nut had worked off.

797. Q.—What would be the effect of a break-down of the low-pressure steam, or high-pressure air side of the 8½-ins. compressor?

A.—The high-pressure steam and low-pressure air side would still operate compressing air to about 40 lbs. pressure in the main reservoir.

798. Q.—What is likely wrong if a compressor, under the conditions cited, will not make a stroke in either direction, 9½ ins., 11 ins., 8½ ins. or the No. 5 or 6?

A.—A serious defect of, or breakage of some part of the steam valve mechanism.

799. Q.—How is a defective condition of steam piston packing rings detected?

A.—By a blow at the exhaust or engine stack between exhausts of the compressor.

800. Q.—What might be wrong with the compound or duplex compressors when air valves are in good condition, but compressor is lame, works very slowly and will not compress air to a very high pressure?

A.—It may be due to broken steam cyl-

inder gaskets between the cylinders and center piece, permitting steam to flow from the high into the low pressure cylinder.

801. Q.—What generally prevents the high pressure air piston of the compound pump from making its full stroke when the other side is operating correctly?

A.—Generally very badly leaking low-pressure steam piston packing rings.

802. Q.—What is the effect of leaking high-pressure air piston packing rings?

A.—A low rate of efficiency and a slowing up in the speed of the compressor.

803. Q.—How does this affect the speed of the compressor?

A.—Air passing the rings permits of a higher pressure than 40 lbs. for the low-pressure air piston to work against, with a consequent slowing up of the compressor all around.

804. Q.—How are leaking packing rings of the low-pressure air piston detected?

A.—By a reduction of the amount of air that is drawn into the cylinder through the air strainer.

805. Q.—Is this same thing true of the No. 5 and No. 6 compressors?

A.—Yes.

806. Q.—Do not leaky air valves tend to produce the same effect?

A.—Yes.

807. Q.—How is the difference between leaky packing rings and leaky discharge valves detected in the duplex compressor?

A.—By pumping up a considerable pressure in the main reservoir, then removing the oil cup when the pump is shut down. A blow back from the oil hole will then indicate leaky discharge valves.

808. Q.—How are the defective packing rings of the high-pressure air piston then detected?

A.—By starting the compressor, and a blow from the oil hole while the piston is on the down stroke will denote packing ring leakage.

(To be continued)

Train Handling.

(Continued from page 149, May, 1919)

815. Q.—What would be the effect of the governor pipe breaking?

A.—The governor would not control the main reservoir pressure with the brake valve handle on lap or in application positions?

816. Q.—What would be done if the valve handle was to remain on lap position for any considerable length of time?

A.—The compressor would be throttled down to prevent an exceptionally high main reservoir pressure.

817. Q.—Would it be necessary to plug the broken pipe?

A.—Not if the proper size 3/32-in choke fitting is used in the governor pipe connection, and if the compressor is of large capacity.

818. Q.—What would control the pressure with the valve handle in the first three positions?

A.—The excess pressure governor top.

819. Q.—What would occur if the excess pressure operating pipe was broken off?

A.—The excess pressure top could not control the main reservoir pressure.

820. Q.—What would control the pressure in the first three positions of the brake valve handle?

A.—The maximum governor top.

821. Q.—What would be the effect of the excess pressure governor pipe breaking?

A.—The governor would hold the compressors shut down.

822 Q.—In what manner?

A.—Through the air pressure leaving the spring box of the excess pressure top.

823. Q.—And this would permit?

A.—Main reservoir pressure under the diaphragms to unseat the diaphragm valve and hold the compressors shut down.

824 Q.—Will a bad leak in the pipe have the same effect?

A.—Yes, if it can reduce the pressure in the spring box.

825 Q.—How long would the compressors remain shut down with brake valve in running position?

A.—Until the main reservoir pressure has reduced to about 40 lbs.

826. Q.—How are temporary repairs made?

A.—The leak from the feed valve pipe is stopped and the union connection of the operating pipe is disconnected and a blind joint inserted.

827. Q.—And this cuts off the pressure from where?

A.—From both above and below the diaphragms of the excess pressure top, allowing the maximum top to control the compressor in all positions of the brake valve.

828 Q.—What would be done in the event of a broken feed valve that would not supply the brake pipe, or with a feed valve piston stuck shut?

A. The brake valve handle would be used partially in release position, that is the brake pipe would be supplied from a position between release and running positions

829 Q. Can the brake pipe pressure be regulated in this manner?

A. Yes, to a certain extent.

830 Q. What could be done if the engine brake persisted in "creeping on" while the brake valve handle was partly in release position?

A. The release pipe between the brake valves can be disconnected or have a leak started at this point

831 Q. What would be done in case of a gage pipe breaking?

A. It would only be necessary to plug the broken pipe to prevent the loss of air pressure.

832. Q.—What would be done if the reducing valve pipe was to break off?

A.—The adjusting nut of the reducing valve would be unscrewed to prevent a flow of air through the reducing valve and broken pipe.

833. Q.—What features of the brake would be destroyed?

A.—The independent brake and signal system.

834 Q.—Is there any possibility of application cylinder pressure unseating the independent brake valve rotary and releasing the automatic brake at such a time?

A.—Very little, but if it does occur the exhaust ports of the independent valve could be plugged as well as the broken piece of reducing valve pipe leading away from the brake valve.

835. Q.—If the driving wheels were to pick up under a condition of this kind and start to sliding, could the brake on the engine and tender be released without using the automatic brake valve and releasing the train brakes?

A. Yes, by placing the independent brake valve in quick application position.

836. Q.—What would this do?

A.—Open the application cylinder to the atmosphere through the broken reducing valve pipe provided that it has not been plugged.

837. Q.—What would be done in the event of a broken equalizing reservoir pipe?

A.—A blind gasket would be placed in the union connection of the gage pipe tee, and the brake pipe service exhaust port would be plugged.

838. Q.—Why is it necessary to plug the service exhaust port?

A.—To prevent the entire loss of brake pipe pressure if the valve handle was moved to application position.

839. Q.—What would cause the loss?

A.—The draining of the small cavity above the equalizing piston.

840. Q.—How would the brake valve be handled to make a brake application under this condition?

A.—It would be moved slowly to emergency position, making a direct brake application, similar to that of using a back up hose

841 Q.—How should the handle be returned to lap position after the brakes have been applied with the desired degree of force?

A.—By gradually moving the valve handle back to lap position.

842 Q. Why gradually?

A.—So that the rapid movement of brake pipe pressure toward the brake valve would not be stopped suddenly, tending to cause a jam up and possibly a release of brakes on the head end of the train.

843 Q. What occurs at the equaliz-

ing reservoir pipe breaks, or as the reservoir is disconnected?

A.—The equalizing discharge valve lifts and discharges brake pipe pressure.

844. Q.—Could a sudden increase in brake pipe pressure cause this?

A.—Not with the brake pipe volume when coupled to a train of cars.

845. Q.—What should then be done if the equalizing discharge valve lifts while running along the road?

A.—The brake valve handle should at once be placed in release position to temporarily keep the brakes from applying.

846. Q.—And then?

A.—Close the brake valve cut-out cock if located in the brake pipe.

847. Q.—What could then be done if there was not sufficient brake pipe leakage to apply the brake?

A.—The train might be run for some distance in this condition, or it might be possible to plug the exhaust port and insert the blind gasket without stopping the train.

848. Q.—What if it became necessary to stop the train while repairs are being attempted?

A.—The brake valve handle could be placed in emergency position, and the brake valve cut-out cock opened.

849. Q.—What can be done if the brake pipe is broken forward of the brake valve branch?

A.—The pipe would be plugged toward the brake valve.

850. Q.—How is a pipe of this size plugged in a satisfactory manner?

A.—Sometimes the broken pipe can be screwed out of a socket or fitting and a wooden plug whittled and screwed into the fitting, but a successful way is to pack the broken end with wet waste and mash up the end of the pipe a trifle.

851. Q.—And the result?

A.—The air pressure will drive the wet waste into the end of the pipe, making a tight joint.

852. Q.—What if the brake pipe is broken off back of the brake valve branch?

A.—The general practice is to plug the pipe toward the brake valve, and couple the brake and signal hose together on the pilot and between the engine and tender, and charge the brake pipe of the train in this manner.

853. Q.—What if the engine has no train signal equipment?

A.—It would be handled as will be explained in connection with a broken brake valve branch.

854. Q.—Can brake pipe and signal hose be coupled together without any trouble?

A.—It depends upon the amount they are worn; it is generally necessary to use a hammer and drive them together.

(To be continued)

Car Brake Inspection.

(Continued from page 151, *May,* 1919.)

745. Q.—What percent of increase in volume is used in the brake cylinder?

A.—Roughly stated, the standard piston travel for the empty cylinder is 8 ins. and the load cylinder 1½ ins. both cylinders being of the same size the increase in brake cylinder volume or in compressed air consumed will be 1½÷8 or about 19 per cent

746. Q.—How is the leverage ratio affected by the load cylinder?

A.—It is increased about 1½ times by the load cylinder.

747. Q.—Why is this increase permissible?

A.—Because the empty cylinder takes up all of the slack in the brake rigging and provides the necessary shoe clearance.

748. Q.—If the empty car cylinder has a leverage ratio of say 9 to 1, and the load cylinder is multiplied by one and one-half in transmission to the empty cylinder lever what is the total leverage of the load cylinder?

A.—The multiplication will be 1½ x 9 or 13½ to 1.

Q.—As an example, if the empty cylinder braking ratio to the car and load is as low as 16 per cent, what will the load cylinder produce if the proportion of the load cylinder lever is as 1½ to 1?

A.—It will be 1½ times 16, or 24 per cent.

750. Q.—And the total for both will be?

A.—Sixteen plus 24 or 40 per cent for the car when fully loaded.

751. Q.—How much more effective then is the load cylinder in producing retarding force for the heavily loaded car?

A.—Where the load ratio to the weight of the car is as much as 3¾ to 1 and 16 per cent braking ratio total is developed from the empty cylinder and 40 per cent total from both cylinders, the efficiency of the load cylinder is as 40/16 or two and one-half times as effective as the empty cylinder or rather as the single capacity brake.

752. Q.—How often should a brake cylinder be lubricated?

A.—As often as the rules of the company specify, or as often as conditions of service may require.

753. Q.—How is the brake piston of a passenger car removed for the cleaning of the cylinder?

A.—By removing the nuts from the non-pressure head and withdrawing the piston.

754. Q.—How is the dirt and heavy grease removed from the brake cylinder?

A.—It can be scraped off with a suitable tool and then cleaned with a piece of waste saturated with kerosene or carbon oil.

755. Q.—What should be used in wiping the cylinder dry after the dirt has been removed?

A.—Rags rather than waste.

756. Q.—Why should not waste be used?

A.—Because small particles of lint remain in the cylinder and tend to produce packing leather leakage.

757. Q.—What groove is the cylinder should be cleaned?

A.—The leakage groove.

758. Q.—What is the purpose of the leakage groove?

A.—To permit of a small quantity of compressed air entering the brake cylinder, when not intended, to escape without moving the piston.

759. Q.—At what time would compressed air enter the brake cylinder when it is not desired?

A.—While running along the road.

760. Q.—How could triple valve be moved to permit a small quantity to flow into the cylinder?

A.—Through brake pipe leakage, and possibly a defective feed valve, permitting just enough variation in the brake pipe to produce movements of the triple valve.

761. Q.—After the cylinder is cleaned, how should it be lubricated?

A.—Very sparingly with the grease or compound furnished for the purpose.

762. Q.—How should it be applied?

A.—Preferably with a brush.

763. Q.—In about what amount?

A.—In from 4 to 6 ounces for one cylinder, the amount depending upon the size of the brake cylinder.

764. Q.—Is 6 ounces enough lubricant for an 18-in. cylinder?

A.—Yes, if properly applied.

765. Q.—Why is such a small amount recommended?

A.—Principally for the purpose of preventing any lubricant from working out of the cylinder through the triple valve.

767. Q.—What is the effect of this lubricant passing into the triple valve?

A.—It moistens the triple valve slide valve, which should remain dry if the best results are to be obtained.

768. Q.—What is the effect if dry graphite has been used on the triple valve slide valve seat as a lubricant?

A.—It causes the graphite to collect and give considerably more trouble than if the slide valve had been perfectly dry or oiled in the first place.

769. Q.—What is the general effect of brake cylinder compound being deposited on the triple valve slide valve?

A.—Undesired quick action and stuck brakes as well as slid flat wheels may be the result.

770. Q.—How should the brake piston be cleaned?

A.—If the leather has been removed it may also be scraped and cleaned with coal oil.

771. Q.—If the leather has not been

removed why should kerosene oil not be used?

A.—Because this oil destroys the filler which has been placed in the leather by the manufacturers for the prevention of leakage through the leather.

772. Q.—What should be done if the cylinder leather is badly worn?

A.—It should be renewed.

773. Q.—What disposition should be made of old leathers?

A.—If not cut in half or burned up they can be returned to the manufacturers for retreating.

774. Q.—What does the retreating consist of?

A.—Principally in removing all of the dirt and grease and renewing the filler in the leather making it as good as a new leather as far as leakage is concerned, at a very small cost per leather.

775. Q.—What should be noticed in connection with wear of parts of the non-pressure head?

A.—That the cylinder head is not excessively worn, also that the piston rod or sleeve is not badly worn.

776. Q.—What should be done if they are badly worn?

A.—The defective parts should be renewed.

777. Q.—Why?

A.—The wear may result in packing leather leakage, and if allowed to continue in service the wear of the piston rod will eventually result in a bent piston and possibly a delay.

778. Q.—What should be noticed in connection with the brake cylinder release spring?

A.—That it is not badly worn or weak; if so, it should be renewed.

779. Q.—What is the effect of a weak spring?

A.—After the cylinder becomes partially dry or after the heavy grease starts to accumulate in the cylinder or if some part of the brake rigging does not move freely, the spring will not be able to return the piston to release position and the shoes will probably drag on the wheels.

780. Q.—What is the effect of shoes dragging on the wheels?

A.—A loss in money through running a train with the brakes partially applied.

781 Q.—Is this a serious loss?

A.—With some designs of foundation brake gear it is a very serious loss.

782. Q.—Principally in what way?

A.—In the additional amount of coal that is shoveled into the fire box of the locomotive, and it also results in unnecessary brake shoe wear, and hot journal boxes.

783. Q.—What is the most important part of the brake cylinder as having a bearing on the amount of air that will escape from the brake cylinder through leakage?

A.—Next to the leather itself, the expander ring.

784. Q.—What should be particularly noticed with reference to the condition of the expander ring?

A.—That it is round, that is, has or will have the proper contour of the cylinder after it is in place?

785. Q.—How can this be determined?

A.—By using a gauge.

786. Q.—What could such a gauge consist of?

A.—An iron band perfectly round on the inside and enough smaller than the bore of the brake cylinder to approximate the average thickness of the packing leather, and the expander ring should then fit this band perfectly, all parts of the outside of the ring touching the band.

787. Q.—Would it be practical to carry such gages from car to car when brake cylinders are being cleaned?

A.—No, it will not be necessary, when there is any question about the condition of the ring it can be replaced by a ring that is known to be perfect, and the removed one can be gauged before being returned to service.

788. Q—What else should be noticed?

A.—That there are no sharp corners at the ends of the ring that would tend to cut through the leather.

789. Q.—What should be observed in connection with the studs and nuts of the brake cylinder piston?

A.—That the studs are tight in the piston and that the nuts are tight on the studs before the piston and leather are replaced?

790. Q.—In renewing a stud, what should be observed?

A.—That the threads in the piston are perfect, then red or white lead should be used on the threads before screwing the studs in place.

791. Q.—How many threads per inch are cut on these brake cylinder studs?

A.—Twelve.

792. Q.—What is the standard thread per inch for half-inch bolts or studs?

A.—Thirteen.

793. Q.—What is the result of screwing a standard thread stud into the 12 threads in the piston?

A.—Ruined threads and leakage past the studs.

794. Q.—In replacing the brake cylinder piston, how should the leather be returned?

A.—That part of the leather that was previously at the bottom should be placed at the top of the cylinder.

(To be continued)

Improvements in Steel Making.

Amongst war-time research work the benefit of which will be permanent better control of the heat treatment of steel promises valuable results. It is now widely recognized that comparatively few degrees variation in the temperature makes all the difference in the properties of the finished material. The difficulties are particularly great where large masses of steel are concerned, because it is difficult to secure the same temperature at the surface and in the mass of the metal. Other difficulties are introduced by the different scaling tendencies and different emissivities of the various steels. Recent improvements in furnace construction facilitate the attainment of uniform temperatures, and the means and methods of pyrometry have been developed to such an extent that the most delicate heat treatment can be given with almost mathematical certainty and on the basis of a commercial repetition process.

Gears and Pinions.

The Van Dorn & Dutton Company, Cleveland, Ohio, manufacturers of gears, have opened branch offices at New York and Chicago. At both cities it is their purpose to specialize in gears and pinions for electrical work. Harry F. Keegan, formerly with the Chicago Surface Lines, and well known in the electrical railway field, will manage the Chicago branch, with offices at 1241 First National Bank building. His brother, John Keegan, will manage the New York end, with offices at Room 317, 30 Church street. John hails from the Interboro Railway, where a third brother is now engaged. Friends of the Keegan brothers say the new connection is an ideal one, and predict a most succesfuul business for the Van Dorn and Dutton Company at their new branches.

Clearing Up the Railways in France.

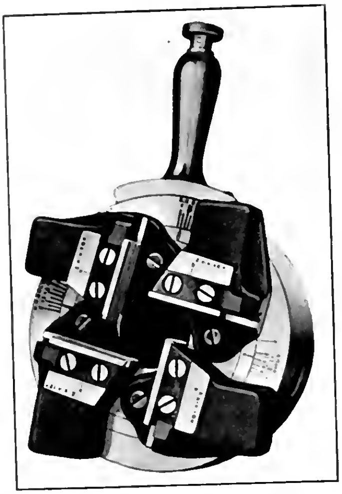
It is stated by the Allied Commission that among the problems connected with the clearing up of the war areas is that of the disposal of the railways. The Allies have expressed their willingness to allow France to retain such lines as may be required for commercial purposes, but a good deal of the mileage is not required by the French government. The Commission has plenary powers, and the surplus equipment will be offered to the world's buyers.

Reading.

The importance of reading, not slight stuff to get through the time, but the best that has been written, forces itself upon me more and more every year I live; it is living in good company, the best company, and people are generally quite keen enough, or too keen, about doing that, yet they will not do it in the simplest and best manner, by reading.—*Matthew Arnold.*

Improved Automatic Screw Cutting Die Head

Among recent improvements in shop tools we note that the Landis Machine Company, Waynesboro, Pa., have placed upon the market a new style of automatic screw cutting die head, shown in our illustration, which is different in design from other heads of this type in that the chasers are supported on the face of the head. This permits of easy access to the chasers when it is necessary to remove them for grinding and changing from one diameter to another. It is made of steel and its sturdy construction insures a long life of hard service. The head is opened automatically by retarding the forward motion of the carriage, and is closed by hand. It is locked by the operating handle which contains a latch having a tongue milled on the lower end. This tongue is milled off center, thereby permitting of roughing and finishing cuts. To adjust the head for either roughing or finishing cuts merely requires a half turn of the latch to suitable graduations.



LANDIS NEW DESIGN OF SCREW CUTTING DIE HEAD

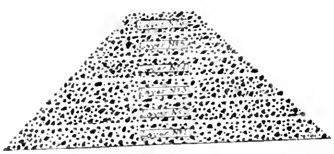
The head is graduated for all sizes of bolts and pipe, both right and left hand within its entire range. It is adjusted to size by means of an adjusting screw which engages the head body. Since the operating, adjusting and closing rings remain in a fixed position when the head is closed, the rotating of the head body within these rings give the diameters within the range of the head. To set the head for left hand threading, the screw which locks the latch pin is removed and the latch pin is rotated to the left hand graduation. The locking screw is then replaced and left hand holders attached.

This head is applicable to practically all makes of screw machines and turret lathes which have sufficient space to swing heads of these diameters. The head is furnished with a standard shank, or special shanks will be furnished, provided they will not be larger than the standard shank. Where special shanks of dimensions greater than the standard shanks are required the customer will furnish a bushing to insure proper application of the head to the machine. This automatic die head employs the long life Landis chaser, which is conceded to be the most efficient and economical threading tool.

The Storage of Coal.

Eugene McAuliffe, manager, Fuel Conservation Section of the United States Railroad Administration, has issued detailed instructions in regard to approved methods of coal storage. Much attention is given to method of unloading where locomotive cranes with clamshell buckets are used, recommendations being made that two parallel tracks, located at from 16 to 20 feet centers, should be laid down on high level ground cleared of all refuse and combustible matter. The loaded cars are placed on one track and unloaded by a crane operating on the parallel track, the coal being placed in a pile alongside the crane. The position of the cars and crane to be reversed with the completion of the first pile of 2 feet in thickness. The clamshell should be lowered to a point just above the surface of the pile before the contents are dumped. The second and succeeding piles, each 2 feet in thickness, to be laid down in the same manner. This method of unloading will eliminate the accumulation of broken fine particles in the center of the pile, and in addition gives the coal a limited opportunity to season before being covered up by the succeeding layer.

Where locomotive cranes are not available, coal from necessity is frequently stored by unloading self-clearing cars placed on a track on the top of the pile,



CROSS SECTION OF COAL PILE SHOWING APPROVED METHOD OF PILING

the track raised from time to time on the coal. This arrangement has the disadvantage of causing an accumulation of crushed coal in the center of the pile, with lumps on the outside. In no case should coal from different districts or from different seams located within the same district be mixed together. Well screened coal carefully piled is rarely known to suffer from heating, for the reason that a minimum surface is subjected to oxidation, the opening between the lumps admitting of any heat engendered passing off. Fire usually starts in piles where the coal is more or less separated in coarse and fine strata, the air entering through the coarser strata acting on the finer portion, which is too dense to admit of the heat created passing off with sufficient rapidity to prevent firing. Fine coal should be invariably stored by itself, and in such a way as to exclude as far as possible the air from entering the pile. Water entering the bottom of a storage pile is exceedingly dangerous from a firing standpoint. The accompanying sketch shows a cross section of a pile laid down as in the manner recommended.

Toolmakers Sharpening Up.

Planning to hunt in packs, and to keep their noses at the grindstone to put across American industry in the strife of world trade soon to follow the reluctant signing of the peace treaty, the members of the National Toolmakers' Association, in annual convention at Atlantic City, N. J., last month set lines in fine working order that will make their industry as useful to America in winning and maintaining supremacy in trade as it was in shaping the engines of offence and defence during the war. The message of every speaker brought a warning of the keen competition that must follow the peace-time efforts of the nations to acquire the world's trade.

"To successfully meet the fiercest kind of competition on the trade routes throughout the world, we must standardize American equipment and put back of our foreign trade expansion campaign of all of the tremendous volume of equipment and co-operative effort which the nation demonstrated in its preparations for armed conflict," was the admonition of Allen Walker of New York.

James Watt Centenary.

One hundred years will have elapsed on August 25 of this year since the close of James Watt's life, in Birmingham, England, the city of his adoption. It has been decided to erect a monument to his memory there. The benefits which his genius bestowed on humanity were such that it is expected that the occasion could only be worthily commemorated by an international appeal to all interested in the generation and use of motive power. R. B. A. Ellis, Commerce Building, Birmingham, is honorary secretary of the Provisional Committee.

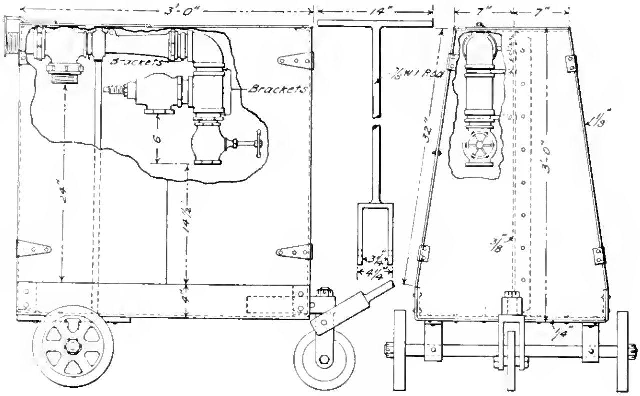
Portable Locomotive Boiler Wash Wagon

By A. C. Clark, Pittsburgh, Pa.

The attached drawing shows a boiler wash wagon that has proved to be a very handy appliance at division points where it may not be always convenient to place locomotives in the roundhouse for washing out the boiler. The appliance being readily portable may be used anywhere within reach of the attached hose.

The bottom or floor part of the wagon is made of ¼-in. steel, the sides being flanged upwards 4 in. in height. The sides are ⅛-in. in thickness, as are also the end sheets, being joined together as shown in the drawing. The sides are hinged and are supplied with two enclosing harps, one on each side, so that the wagon can be locked or closed up tightly when not in use, preventing the wrenches or other tools from being lost or stolen.

One side of the wagon is adapted for holding the hose, the other side for the washer, including the steam and water inlets, and outlet as shown. When the appliance is not in use a sliding plate is moved down over the outlet as shown in order that no dirt or oth_r obstruction can get in. The top part is divided by a ⅜-in. partition, which serves also to stiffen it besides furnishing a means of support. The rear wheels are 10 ins., and the front wheels 8 ins. in diameter.



DETAILS OF BOILER WASH WAGON

The floor space is 3 ft. in length by 2 ft. in width. The height from the floor bottom to the inner edge of the roof is 3 ft. The handle for hauling or propelling the wagon need not exceed 3 ft. in length. The brackets may be of steel or wrought iron ⅜-ins. by 2¼ ins., 7 ins. in length being sufficient metal to bend over in forming the brackets. The coupling for handle and axle bearings will readily suggest themselves to the intelligent mechanic.

Consolidation Locomotive for New South Wales

By C. F. Dewey, Sydney, Australia

The accompanying illustration depicts a locomotive of the 2-8-0 or consolidation type which has quite recently been constructed by the Clyde Engineering Co. of Granville, Sydney, for the New South Wales Government Railways, as part of a contract for 300 new engines.

This engine was designed for freight train operation, by E. E. Lucy (late Great Western Railway, England), Chief Mechanical Engineer of the system, and while N. S. W. standard constructional practice has been generally adopted, a number of new features have been introduced. It is equipped with rocking fire-bars and drop grate; ash-pan hopper slides worked by steam; ash-pan washing apparatus; hot water smoke-box ash ejector; exhaust injector; and Lucy superheater (designed by the C. M. E.). The boiler can be blown down while the engine is in motion. The Southern Valve Gear with outside piston admission valves has been selected; this is believed to be the first appearance of the Southern Gear in Australia; and also the first appearance of outside motion on the road engines of the New South Wales system.

This engine is designated No. 1353 "K" class, and is attached to the main running shed at Eyeleigh. It bears the usual livery of the road (i. e., black with red lines and facings, and brake numerals on the cab-sides), and it presents a fine solid appearance. It is designed to run 500-

CONSOLIDATION 2-8-0 TYPE LOCOMOTIVE FOR NEW SOUTH WALES

mile trips without any shed attention, the crews being changed on the road; and since being placed in service, it has been given some very heavy work to perform, with very satisfactory results.

Its leading dimensions are as follows: Cylinders, 22 ins. diameter x 26 ins.; driving wheels, 51 ins. diameter; leading truck wheels, 33½ ins. diameter; heating surface, firebox, 174.4 sq. ft.; tubes, 1582.5 sq. ft.; superheater, 444.8 sq. ft.; total, 2201.7 sq. ft. Boiler pressure, 150 lbs. per sq. in.; tractive effort, 31,460 lbs.; total weight (engine and tender), 123 tons, 12 cwts; total length, 60 ft. 10¾ ins.; gauge, 4 ft., 8½ ins.

The tender carries 14 tons of coal, sufficient for continuous heavy haulage for 300 miles.

Pre-Heating Work for Oxy-Acetylene Welding

By J. F. Springer

The pre-heating of work that is to be welded by means of the oxy-acetylene torch is one of the most important features connected with the successful use of this instrument. In fact, some heavy work, particularly castings, could scarcely be done with success, if it were not for the assistance of pre-heating, and mayhap after-heating as well.

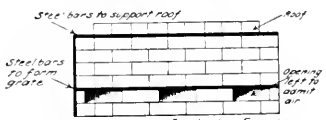
The great usefulness of gas welding depends upon the possibility of localizing the heat. Metal in the work is brought to and near to the melting point. But this applies only to the immediate region of the weld. The remainder of the work may often, for the most part, be as cool as the temperature of the shop. The bluish tip of the little white flame has an enormous temperature itself and is capable of imposing a high temperature upon a limited region of the metal. The great success of gas welding turns upon the ability of the high-temperature torch to concentrate the region of its activity and thus avoid involving the whole for the sake of a part.

And yet, there are cases where a good thing may be pushed too far. Its very perfection in accomplishing a desired result may, under unfavorable circumstances, prove a limitation to its application along certain lines. This is the case with oxy-acetylene welding. The concentration of high temperatures within very limited areas, especially in the case of good sized castings, contains within it the possibilities of damage. There is, it may be, no trouble in heating the edges of the groove and in melting new materials onto molten old, and yet at some point in the operation or during the cooling, the work may develop a new crack. Pre-heating and after-heating have largely in view the prevention of just this undesired result. If it were not that those precautionary measures are capable of being carried out with great success, oxy-acetylene welding would not be suitable for a good deal of work. And what has been said as to oxy-acetylene welding applies more or less fully to competing systems of welding—in fact, to all systems which proceed by the localization of high temperature.

The danger of cracking requires some explanation, perhaps. At any rate, a clear understanding of the activities at work will be of great value to the workman in carrying out pre-heating and after-heating operations.

Metals in general expand when heated and contract when cooling. This expansion and contraction goes on with exceeding slowness. And yet, the blacksmith utilizes the thing whenever he shrinks a tire onto the felloe of a wheel. The crevice between the ends of two railroad rails may be quite wide in winter and quite narrow in summer. The explanation is that the rails are really longer in warm weather and shorter in cold. When a railroad rail is cut off at the steel works just after it has passed through the final pass of the rolling mill and when it is still perhaps at a red heat, it is cut off longer than is desired for the rail when it is cold. Just the right amount of excess is allowed, and when the rail cools slowly down it approaches closer and closer to the standard length.

Steel lengthens, broadens and thickens at a pretty definite rate for each degree the temperature rises, and contracts similarly along its length, breadth and thickness. The proportionate amount for 1 degree Fahrenheit is very small, being only about 0.0000066 part of each dimension. That is, a rail lengthens 66 ten-millionths of itself for each degree. Similarly, for breadth and thickness. For a few degrees, it amounts to too short an addition to attract attention. But, in cases where the additions continue at about this rate for every degree between shop temperature and the temperature of melting, the amount becomes noticeable.



Side Elevation of Pre-heating Furnace Set up temporarily Steel bars used for grate

Taking the melting point of steel at 2,500 degrees and the room temperature at 100, the heating up to the melting point and the cooling off from that point cover a range of 2,400 degrees. The steel will change in length, breadth and thickness 2400 times as much as for 1 degree. This means a change of about 0.016. The length changes 16 thousandths of itself; the breadth 16 thousandths of itself; and the thickness, 16 thousandths of itself. If, for example, the length, breadth or thickness is 2 feet, then it will change 16 thousandths of 2 feet ($2 \times 0.016 = .032$ feet $= .384$ inch). This change in 2 feet amounts to more than ⅜ inch.

That the change mounts up for high heats is readily seen from the example of the tire shrunk onto a felloe. The tire may be only 30 inches, say, in diameter, i. e., about 94 inches all around. It will be distinctly too small for the felloe; and yet, when heated to a fairly bright color, it may be readily slipped over it. Cooled off by a bucket or so of water, the tire is found to have shrunk and gripped the felloe firmly.

With this little digression in mind, the reader will, perhaps, have no great difficulty in seeing that some pretty important occurrences take place when a good big crack in a casting is being repaired by the oxy-acetylene process. The sides of the groove will be heated up, say, to 2,500 degrees or more, and a region of the work near by will be heated up to a pretty high point. Then the temperature falls off, away from the groove. In fact, one may have 2,500 degrees at the groove and only 1,000 degrees a very short distance from it. And a very short distance further, the 1,000 degrees may fall to only 200 or 300. If a crack is, say, at the center of a large area of metal, we will have a big, broad ring of unheated metal all round the heated region. This unheated ring will neither expand nor contract; it will retain its size and condition. But, inside the ring, are many degrees of swellings. With the inside seeking to get bigger—and seeking with enormous force—and the outside remaining just as it was, is it any wonder that something gives way and a crack develops?

Consider now the weld itself—the filling of new metal in the groove. Every particle of this plug of metal has been at the melting point. While the groove is not filled suddenly, after the manner that a mold is filled in a foundry—it may make the exposition easier to grasp, if I assume that this is the case, and later on make allowance for the difference. The weld then exists at first as a molten mass. Where it is in contact with the sides of the groove, there will be a thin layer of molten metal; but, in general, the temperature of the work surrounding the weld will be distinctly lower than that in the weld itself. When work and weld have cooled off, the weld has shrunk more because it has cooled from a higher point. Now something analogous to this takes place in actual practice. The new metal is put in a little at a time, and all that. Still, it will not be hard to grant, perhaps, that every part of it has been at a higher temperature than the work surrounding the weld. Is it any wonder, then, that upon cooling, the weld at times cracks away from the work?

Now, it has been found that the very best means of combatting the crackings in the work and between work and weld consist in pre-heating and after-heating. The thing that is pre-heated or after-heated is an enlarged region surrounding the groove or the whole casting. The idea in the one case is to increase the

distance between the molten condition of metal at the groove and the unchanged condition away from it. This will reduce the necessity for such sudden drops in temperature as one goes from the weld. In the other case, the total drop in temperature from the heat in the weld to the coolest part of the work is cut down sharply.

For example, under conditions where no pre-heating is done, one may find only an inch or so between molten metal and metal scarcely heated at all. If heat is spread over more territory, by the use of a coke fire or other means, the distance may be increased in accordance. If this is skilfully done, there will then be only gradual changes in temperature as one goes from point to point. Or, suppose that instead of enlarging the heated region but nevertheless leaving an outlying region unheated, one puts the whole casting into an oven and heats it up, say, to a point about half way through the red. This will be about 1,300 degrees F. The difference between the melting point (2,500 degrees) and room temperature is cut down about one-half. This changes the situation enormously.

Where other metals than iron and steel are in consideration, there are similar advantages. Copper, brass, bronze, aluminum, all have lower melting points. Pre-heating may accordingly be expected to do still more for them in proportion to the temperature of the pre-heat; or else the pre-heating may be made to secure about as much by the use of a lower temperature of pre-heat.

Some Examples.—As an illustration of the first method of pre-heating—that which enlarges the heated area—I will cite the case of an enormous kettle which weighed about 18,000 pounds and had a wall thickness of several inches. The metal was cast iron. A crack a couple of feet long developed in the bottom and the welding job concerned the repair of this crack. The kettle was set bottom side up. The crack was cut to form a groove having the opening up, the kettle standing upside-down. A charcoal fire was built underneath and was so operated as to heat the general region about the crack and not simply the crack location. The fire was made in a temporary oven constructed of loosely laid brick. In the course of some two and one-half hours, a dull red heat was produced. Naturally, the temperature faded away from the crack. The welding operation lasted, it seems, some half dozen hours. During this period, the fire was kept going.

It should be pointed out here that not only did the pre-heating serve as a precautionary measure against the formation of new cracks but it also served an economical purpose. That is to say, the expensive gases used in the torch were not employed to get the heat up from normal to the dull red heat. Charcoal did that. The torch began with the groove at a dull red and carried the metal in its sides up the remainder of the temperature range required.

In a case like this, the operator would be subjected to severe heat radiating from the work to his face and other exposed parts of his body, unless some precaution is taken. Asbestos sheeting is a proper thing to lay on heated metal to prevent uncomfortable radiation. The sheeting may cover everything that is heated except the immediate location at the groove where actual welding is going on.

Pennsylvania Railroad System.

The Annual Record of Transportation Lines of the Pennsylvania Railroad System, which has just been issued, shows that the Pennsylvania Railroad Company and the corporations controlled and associated in interest with it, both east and west of Pittsburgh, own a total of 11,942.66 miles of railroad line. Of the total mileage, 3,937.26 miles are double track, 850.51 miles are three-track, and 648.86 miles are four-track. The total trackage of the System, including sidings and yards, is 27,795.64 miles.

The title to the various portions of the railroad mileage constituting the Pennsylvania System is lodged in the Pennsylvania Railroad Company proper and 113 subsidiary railroad corporations. The parent company owns directly 2,905.77 miles of line, all of which lies in the State of Pennsylvania, and constitutes the highest mileage in the name of any one corporation of the System. The lines constituting the Pennsylvania System traverse thirteen States and the District of Columbia, the States in question being Delaware, Illinois, Indiana, Kentucky, Maryland, Michigan, Missouri, New Jersey, New York, Ohio, Pennsylvania, Virginia and West Virginia.

East of Pittsburgh the Pennsylvania System owns 6,549.71 miles of line and 15,851.65 miles of track. West of Pittsburgh it owns 5,392.95 miles of line and 11,943.99 miles of track. The greatest mileage in any State is located in Pennsylvania, in which the System owns 4,289.00 miles of line. Ohio is second on the list, with 2,141.47 miles, and Indiana third, with 1,664.19 miles.

Public Favors Return of the Railroads.

The Association of Railway Executives submitted a series of questions to every editor in the country in regard to government control or private management of the railroads. The result has shown that public opinion is very strongly in favor of an early return of the railroads to their owners. The strongest sentiment against government ownership was found to be in New England and the south sections widely apart in political sentiment. Only 4 per cent of New England editors, and 7 per cent of southern editors, reported that their people were in favor of government ownership.

In the North Atlantic States (New York, New Jersey, Pennsylvania, Delaware, Maryland) 86 per cent estimated public opinion as favoring the return of the roads, while 7 per cent thought public sentiment opposed it, with 7 per cent doubtful and blank.

In the Great Lakes States (Illinois, Indiana, Michigan, Ohio, Wisconsin), 1,032 editors (84 per cent) decided that public opinion in their communities favored the return of the roads, while 125 (10 per cent) voted no; 6 per cent doubtful and blank.

The editors of the Far West (Arizona, California, Idaho, Nevada, New Mexico, Oregon, Colorado, Utah, Washington) voted 79 per cent yes and 15 per cent no on the question of returning the roads to their owners.

Of the editors numbering 13,434, replies were received from 5,992, or 44 per cent, and 83 per cent of the editors reported their communities in favor of a resumption of private management.

Lord Shaugnessy's Opinion of Government Control of Railways.

In regard to government ownership of railways Lord Shaughnessy, President of the Canadian Pacific railway, stated at a recent meeting of the Canadian Club of Canada, held in Montreal, that he was a bitter opponent of government ownership and control of railways. If there were no other reason for this it would be that it tends to destroy individual initiative, individual effort, and our national life will certainly not be improved by any such change. The theory seems to be that these railways, although owned by the government, can be operated by such independent commissions as will keep them from political interference. The policy and every detail will be governed from Ottawa, and the men engaged in the operation of these lines, no matter how much they may be interested in keeping them aloof from political influence, will find that they cannot do it. The railway official operating under such circumstances naturally becomes a politician. It cannot be otherwise. The outlook of transportation in Canada is far from reassuring by reason of the proposed government control and operation of such a large number of lines.

Practical Fuel Saving.

Through the co-operation of the industrial power plants, the recommendations of the United States Fuel Administration to promote efficiency in the use of fuel in power plants, a saving of 7,000,000 tons annually has been effected by the adoption of new methods.

Electrical Department

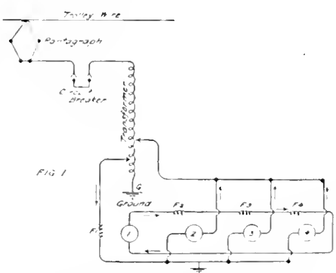
Part II. Regenerating Braking as Applied to Electric Locomotives. What it Really Is

In our last issue we discussed regenerative braking of trains. We pointed out how the electric locomotives operating over the electrified section of the Norfolk & Western Railway change from pulling to regeneration, as the train passes over a hill. We showed the general application and then took up in detail regenerative braking as applied to electric locomotives operating on direct current. We will now consider the other two types of electric locomotives, namely, the single phase and the three phase, both of which operate on alternating current.

The same conditions as regards voltage or pressure apply equally well to the single phase series locomotives as to the DC locomotive. The single phase system and the single phase motor are, however, much better adapted to regeneration than the DC series motor, due to the fact that the motor itself is not as sensitive as the DC series motor. The AC motor can operate through greater variation of current values in the field and the armature, and this increased range means a greater graduation of speed over which regeneration is possible. The direct current series motor will not permit of a very great variation of armature current with a constant field as exists when the motor is in the regenerating position, and the combination of motors in the series and parallel is of course limited. A wider range of excitation is possible to the motor fields of the AC single phase motor, by means of voltage variation due to the use of transformer taps, which is additional to the advantage in the motor itself. This same advantage can be secured in the return of power to the line, from the motors which are regenerating.

The single phase system uses high voltage for the overhead wire, usually 11,000 volts. This high voltage cannot be applied to the motors directly, so that it is necessary to use a piece of electrical apparatus known as a "transformer" to step down this 11,000 volts to a voltage suitable for the motors. A series of coils placed adjacent to each other and surrounded by an iron laminated core constitutes a transformer and, as the word implies, transforms the high voltage to a low voltage. The ratio depends on the ratio of the turns of the coils so that wires or taps can be brought out of the transformer at many places and any low voltage desired can be obtained. The transformer works equally well in the reverse direction; for instance, if the low voltage is applied to one of the low voltage taps, then high voltage exists at the other end.

A diagrammatic sketch of single phase regeneration connections is shown by Fig. 1. The transformer is represented by (A). If 11,000 volts is applied at the trolley or high tension end, there would be a very small amount of electric current, known as exciting current, which would flow through the coils and out of the lead G which is connected to the ground (Grd). If it were possible to measure the voltage throughout every turn of the transformer, beginning at the high tension end, it would be found that there was a decrease in voltage as progress was made along the coils from A toward G until zero voltage was obtained at G. From this it is clearly seen that any voltage can be obtained by bringing out a lead or tap at the proper coil and proper turn.



SCHEMATIC DIAGRAM SINGLE-PHASE REGULATION CONNECTIONS

A motor generator set can be used as in the direct current arrangement if desired, but a very satisfactory arrangement and one especially suitable for AC single phase operation can be used by taking one motor of the four in the locomotive and arranging for this one motor to be the generator furnishing current to excite the fields of the others. This is illustrated in Fig. 1. Motor No. 1 is used as the generator [the power for operating or driving the generator is obtained by the locomotive rolling down the grade] and furnishes current to the fields of the No. 2, No. 3 and No. 4 motors; the armatures of these motors generate current and this current is passed back into the transformer through the lead (C).

As mentioned above, the power to drive the generator furnishing power to the fields and the motors generating current and returning same to the transformer, is due to the locomotive rolling down the grade. The locomotive speed is retarded and the locomotive can be brought down nearly to a stop. As the locomotive speed decreases the voltage from the motor can be kept at a sufficient value to regenerate, by putting more current through the fields of these motors. This is accomplished by increasing the strength of the field of the motor (No. 1) so that it will generate more current for the other three fields. The field is increased by connecting the lead (D) to a higher voltage tap. There is a limit to the voltage that can be placed on (D) so that when this maximum excitation is reached the lower voltage generated by the motors 2, 3 and 4 can still be used, as it is possible to connect lead (C) to a lower tap. Connecting lead (C) to a lower tap increases the ratio of AG to CG so that the lower voltage still gives the necessary increase of voltage over 11,000 V to force current back into the line wire.

We have shown from the above and preceding issue that it is possible to regenerate with both the DC and single phase systems, providing that certain changes in connections are made, and that means are provided for giving the motors the shunt characteristics requiring either the use of a motor-generator set or the use of one of the driving motors. Regeneration on these two systems works very satisfactorily, but as far as simplicity and reliability are concerned, the locomotives driven by the three phase motors are superior.

The three phase motor is of constant speed. The speed at which it runs does not depend upon the voltage of the circuit, but upon the frequency of the electrical supply. For a given frequency there is a certain speed of the motor. If the frequency is increased the speed increases; if decreased the speed decreases. This speed is known as the synchronous speed of the motor. Frequency is usually expressed in terms of "cycles"; for instance, 25 cycles and 60 cycles. Alternating current, as we know, does not give a constant pressure like direct current, but changes in value. Starting at zero, it progresses to a maximum, then decreases to zero, reverses, goes down to an equivalent maximum and returns again to zero; all this takes place in the

fraction of a second. In the case of 25 cycles (the change from zero back to zero being a cycle) there are 25 of these changes each second.

The construction of the three-phase induction motor is as follows: It consists of a stationary winding called the stator, this winding being continuous on the inside of the frame, and a rotating armature called the rotor. The rotor has no connections whatsoever with the stator, and receives no power from the power supply circuit. That is, the power is connected to the stationary winding. In the case of three-phase induction motors, same as used on the electric locomotives of the Norfolk & Western, the power when connected to the stator, rotates electrically in this winding at a speed depending upon the frequency and upon the number of poles of the motor. The revolving field passing by the winding on the rotor, induces a current in it which tends to stop this rotation of the field. As the rotating field cannot stop, the rotor is dragged along at practically the same speed, there being a slight slip depending upon the load or the work which the motors are doing. When the rotor is running in exact step with the rotation in the stationary winding it is running at what is known as synchronous speed.

A simple illustration of this electrical rotation is as follows: Assume there are several electric bulbs in a street sign, arranged in the form of a circle. The uppermost one glows full, while the others are dark. Then No. 2 glows while No. 1 grows dim and goes black. No. 2 fades as No. 3 grows bright, and so on around the circle. This sequence, when performed rapidly, gives the impression of rotation, although the bulbs are stationary.

Regeneration with three-phase motors is both simple and reliable and is due to the fact that if the locomotive speeds up so that the rotor is running above the synchronous speed, the motors begin to regenerate automatically. The reverse of operation just described takes place. The stator running at a speed slightly higher than the electrical rotation in the stator is out of step, so to speak, in the reverse direction to that which it is when operating as a motor, and instead of drawing current from the line, it returns current to the line. It is not a question of generating a voltage to overcome the line wire voltage, as with direct current and single-phase current, but it is purely a question of speed of rotation and a condition which takes place automatically without any change in the motor circuit.

It, therefore, follows that there is no appreciable change in the speed with regeneration using three-phase motors, and the air brake is necessary to bring the train from the operating speed to a stop. The preceding remark is in general true, but there may be special arrangements where the speed can be reduced.

The use of a phase converter in the locomotive, enabling three-phase motors to operate from a single overhead trolley or a single-phase supply, does not change the automatic feature of a regenerative braking. This arrangement is used on the N. & W. locomotives, and the description of the handling of these motors in the first part of this article, published in the last issue, points out how simple and automatic these three-phase motors work. There are no adjustments to be made, depending on change in grades, and the trains descend at a constant speed.

The advantages gained by the use of regeneration are many and can be classified as follows:

1. *Brake shoes and wheels.* The energy stored up in a heavy freight train descending a grade is large, and with only the air-brake available as a means of "letting the load down the mountain" this energy must be dissipated as heat at the brake-shoes, resulting in rapid wear of the shoes, often the overheating and heavy wear of the wheels, with risk of loose and broken tires and rims. Regenerative braking is in use on electric locomotives of the Italian State Railway, and the average life of brake shoes has been increased from approximately 4,500 miles to over 14,000 miles, and a corresponding increase in the life of the wheels.

2. *Speed down grade.* The speed of a heavy train down the grade is very often limited by the permissible heating of the brake shoes, so that with regeneration, the speed can be the safe speed for the track, curves and construction of rolling stock if it is so desired.

3. *Air brakes, brake rigging and draft gear.* The taking of a heavy train down the grade not only imposes severe duties on the shoes and wheels, but also on the air brakes and draft gear as well. The saving in maintenance of rolling stock due to regeneration may be found to be considerable.

4. *Power-house.* When we consider the power-house, we find that the saving in horsepower output from the power-house due to regeneration depends upon the operating conditions and the grades. With all grades on the road of approximately 2 per cent., it might be possible to save 50 per cent in power consumption, while with the average mountain conditions the saving would not probably be in excess of 25 per cent. This saving would decrease depending on the grades and level structures. Even with no saving shown in the power-house output, the other savings are worth considering, especially as the simplicity and reliability of operation are not sacrificed by regeneration.

5. *Safety.* Even if regeneration showed no economies it would be worth while from the safety standpoint. There can be no argument as to the advantage of safety, which is of utmost importance. In going down grade, using air brakes, it is necessary, in order to make schedule time, to operate at varying speeds on different grades, and it is this variation which may result in too high speed on a particular grade or result in bunching the train, due to injudicious application of brakes. With the train held from the front only, descending the grade at practically a uniform speed and with air brakes in reserve for emergency conditions we have reached a degree of safety hitherto unattained.

Stone Franklin Company.

The success that has attended the introduction of the Stone Franklin Car Lighting system in America, and which was introduced by the Franklin Railway Supply Company, has necessitated the formation of a new company which will give its exclusive attention to this new and popular development. The policies of the older company which have been so satisfactory are a sufficient guarantee that the same reliable methods will mark the career of the company. The main office has been established at 18 East 41st street, New York. The officers are Joel S. Coffin, chairman of the Board of Directors; Ralph C. Coburn, president; C. E. Walker, vice-president; H. D. Rohman, chief engineer, and W. Truelove, secretary.

Mr. Coburn, president of the new company, has been prominently identified with the Franklin Railway Supply Company, and has a thorough knowledge of railroad conditions and requirements. He was graduated from Harvard University in 1904. Mr. Walker, vice-president, has had an unusually wide experience in manufacturing, sales, mechanical engineering, both in North and South America, and in England, where he joined the British Army at the outbreak of the war, serving over three years at the front. Receiving the Order of the British Empire early in 1917, he was selected to superintend the manufacture of anti-submarine devices in England, which position he held at the time of his election as vice-president of the Stone Franklin Company. Harry D. Rohman, chief engineer of the company, has also had an interesting career. Since graduating from the technical schools of Zurich, Switzerland, he has had an extensive experience, particularly as an electric engineer in nearly all European countries, including the Balkan States, as well as in South Africa and the Belgian Congo. In addition to his valuable experience in car lighting engineering he speaks many languages, and has already proved himself a valuable acquisition to the railway supply business.

Items of Personal Interest

J. E. Osmer has been appointed superintendent of motive power of the Ann Arbor, with headquarters at Owosso, Mich.

J. D. Culliman has been elected president of the Galena-Signal Oil Company; L. J. Drake, L. F. Jordan and J. E. Linahan, vice-presidents.

H. E. Whittenberger, general manager of the Grand Trunk, Western Lines, has been appointed federal manager, with headquarters at Detroit, Mich.

A. A. Woods has been appointed chief engineer of the Southern railroad, with headquarters at Cincinnati, Ohio, succeeding Curtis Dougherty, deceased.

C. E. Allen has been appointed general master mechanic of the Northern Pacific lines east of Mandan, N. D., with office at St. Paul, Minn., succeeding T. J. Cutler, transferred.

E. F. Blomeyer, general manager of the Ann Arbor, and the Manistique & Lake Superior, has been appointed federal manager of the Ann Arbor, with headquarters at Toledo, Ohio.

William F. Hayes, master mechanic of the Baltimore & Ohio at Chillicothe, Ohio, has been transferred to Washington, Ind., and E. J. McSweeney, formerly general foreman at Garret, Ind., has been appointed master mechanic at Chillicothe, succeeding Mr. Hayes.

George T. Martin has been appointed assitant to the general superintendent of motive power of the Chicago, Milwaukee & St. Paul, with office at Chicago, Ill., and James McGuire has been appointed roundhouse foreman on the same road, with office at Miles City, Mont.

Col. F. A. Delano, formerly president of the Chicago, Indianapolis & Louisville, and who has served with the American Army in France as deputy director-general of transportation, has been made a chevalier of the Legion of Honor in recognition of his services.

George L. Fowler, consulting mechanical engineer, formerly with offices at 83 Fulton street, has removed to more commodious offices at 120 Liberty street, New York. Mr. Fowler is an eminent authority on all matters pertaining to the mechanical department of railways.

C. B. Young has been appointed manager of the inspection and test section of the Railroad Administration in the matter of tests of locomotives, specialties including electric headlights, bell ringers, fire doors and other appliances, with offices at 1800 Pennsylvania avenue, Washington, D. C.

J. C. Rockwell has been promoted from local general manager to vice-president of the Manila Electric Railroad & Light Company, Manila, Philippine Islands, in charge of the general Philippine affairs of that company. This property is under the operating management of The J. G. White Management Corporation, New York, N. Y.

H. L. Worman, master mechanic on the St. Louis-San Francisco, with office at Memphis, Tenn., has been appointed superintendent of motive power, with headquarters at Springfield, Mo., and G. R. Wilcox, assistant master mechanic at Monett, Mo., has been appointed master mechanic, with office at Memphis, succeeding Mr. Worman.

W. L. Conwell has been elected president of the Safety Car Heating & Lighting Company, 2 Rector street, New York. Mr. Conwell has been acting president since the death of R. M. Dixon last year. J. A. Dixon, Randolph Parmly and James P. Sofer were elected vice-presidents. C. W. Walton, secretary and treasurer, and W. Stewart, assistant secretary and treasurer.

Major-General Sir Henry Thornton, inspector-general of railroads in England, formerly general superintendent of the Long Island railway, is at present on a visit to America. During the war he was in complete charge of British transportation in France, and was raised to knighthood by King George, and the Order of Leopold was conferred on him by King Albert of Belgium.

Oscar F. Ostby has been elected president of the corporation of Oscar F. Ostby & Co., with offices at 1044 Grand Central Terminal, New York. The company will continue in the lines of railway supplies so successfully handled by Mr. Ostby, together with other extensions, including the exclusive agency for the Davidson high speed steel and tools, manufactured by the Davidson Tool Manufacturing Corporation, New York.

C. D. Barrett, having returned from service in France, has been appointed engineer of the Locomotive Stoker Company, with headquarters at 50 Church street, New York. Mr. Barrett was commissioned as major in the American Expeditionary Force and commanded the First Battalion of the Nineteenth Engineers, and organized the St. Nazaire locomotive shops, and was latterly appointed assistant general superintendent of motive power of the Transportation Department.

H. H. Maxfield, formerly superintendent of motive power of the New Jersey division of the Pennsylvania, and who was commissioned lieutenant-colonel of the Ninth Engineers of the National Army in July, 1917, and while serving in France was appointed superintendent of motive power of the Transportation Corps American Expeditionary Force, has returned to the service of the Pennsylvania, and has been appointed acting works manager at the Altoona shops, including the machine shops, the Altoona car shops, the Juniata shops, and the South Altoona foundries. The superintendent of motive power has been relieved of the jurisdiction over the above-named shops, the position occupied by Mr. Maxfield being newly created.

John E. Muhlfeld and several other engineers has formed the Railway and Industrial Engineers, Inc., with offices at 25 Broad street, New York City, to act as consulting engineers between the bankers, railroad and industrial corporations. Mr. Muhlfeld for the past five years has been specializing in the development of the "Lopulca" system for burning pulverized fuel in locomotives, stationery boilers and chemical furnaces, and was elected president of the Pulverized Fuel Equipment Corporation and the International Pulverized Fuel Corporation, and has resigned to devote his entire time to engineering work. Mr. Muhlfeld retains his interests in and still remains a director of the Pulverized Fuel Equipment Corporation. In regard to this corporation its work may be said to have reached the stage of entire success, and that special engineering in a broad sense is no longer necessary.

Colonel Douglas I. McKay has been elected president of the Pulverized Fuel Equipment Corporation of 30 Church street, New York, to succeed John E. Muhlfeld, who retires to return to consulting engineering practice. Since July, 1917, Colonel McKay has been engaged in war work. He was commissioned Major in the Ordnance Reserve Corps in charge of the Raw Materials Branch of the Gun Division and purchased all raw and semi-finished materials. In January, 1918, he was promoted to Lieutenant-Colonel of the National Army and appointed Assistant Director of Purchase and Supply. He was subsequently promoted to Colonel and continued in this capacity until he returned to civil life after the armistice was signed. Colonel McKay is a graduate of West Point. Upon graduation he spent three years in the army, resigning to take the position of deputy chief of the Aqueduct Police and six months later was made chief. Three years later he was called to New York City as first deputy police commissioner in charge of the business administration of the department and two years later was appointed police commissioner of New York. After a most successful administra-

tion he resigned the commissionership a year later. Latterly he became assistant to the president of J. G. White & Co., Inc., and two years later was elected vice-president and director, which position he held at the time he entered the United States Army service. In addition to his duties as president of the Pulverized Fuel Equipment Corporation, Colonel McKay is also vice-president and director of the Chemical Foundation, Inc., director of the International Agricultural Corporation and director of the Botany Worsted Mills and other industrial corporations and companies.

Samuel M. Vauclain, senior vice-president of the Baldwin Locomotive Works, has been elected president of the company, succeeding Alba B. Johnson, who had been desirous of resigning the presidency, and whose resignation was accepted at a special meeting of the directors last month. Mr. Johnson retains his interests in the company and remains a director. He has been associated with the company for 44 years, and under his able management the growth of the company's works has been phenomenal. The demand on the company was so great during the war that Mr. Johnson felt it incumbent upon him to remain at his post, and while he is not now by any means retiring from public or commercial activities, his relation to other public and business activities is such he has felt that the growing responsibilities of the company's works should be placed in younger hands, and it is peculiarly fortunate that his worthy and accomplished associate, Mr Vauclain, is so well fitted by education and experience to succeed him.

SAMUEL M. VAUCLAIN

General Miller Continues in the Oil Refining Field.

General Charles Miller will continue his activities in the oil refining field, and has assumed the chairmanship of the board of directors of the Home Oil Refining Company of Texas. This company operates in the Ranger and Burkburnett fields, located in Texas, and has extensive leases of oil lands covering over 30 square miles and which are being rapidly developed. The officers and directors of the company are as follows:

GEN. CHARLES MILLER

President, W. M. Babcock, formerly mid-continent manager of the Humble Oil & Refining Company; operating vice-president and general manager, M. A. Isaacs, Tulsa, Oklahoma; assistant operating vice-president and general manager, John B. Given, formerly associated with General Miller in the Galena Signal Oil Company; vice-president, Sam Davidson, Fort Worth; vice-president, William Churchill, formerly sales manager of Corning Glass Works; treasurer, Benjamin J. Tillar, Fort Worth; secretary, Harry M. Bronner, New York. The board of directors, of which General Charles Miller is chairman, consists of the officers of the company and nine other members, of whom the following have already been appointed: W. C. Stripling, Fort Worth; Sam Levy, Fort Worth; G. H. Colvin, Fort Worth; Paul D. Langdon, New York.

The company's operations cover the entire field of oil production, manufacture and sales, and in addition to the fields in Texas the company operates an oil refinery at Yale, Okla., with a capacity of 2,500 barrels per day. Extensive construction work on new refineries are going on at Fort Worth, Texas, and at Franklin, Pa., the latter plant to be specially used in the production of railroad oil.

The company is fortunate in securing the co-operation of General Miller in its extensive enterprises. His experience extends over half a century, and under his able management the development of special oils to meet the constantly growing requirements of heavier service and higher temperatures was accomplished. Not only so, but the scientific research incident to the development necessitated the creation of a department of experts in lubrication whose educational work has been of marked value, particularly in railroad operations. In this work General Miller has been in the fore front of it all, and like his illuminating oils his work sheds a light that grows bright and brighter as the years pass on.

Subjects at Mechanical Conventions.

In accordance with the regulations regarding the rules of order of procedure the American Railroad Association has issued a calendar for the first annual convention of what is known as Section III —Mechanical, which, as previously announced, will be held at Atlantic City, N. J., June 18 to 25. The arrangements have been completed with a degree of accuracy of detail that would be difficult to surpass, and the Railway Supply Manufacturers' Association has prepared an exhibit which, while retaining all the features of previous railway mechanical exhibits, will be marked by many new improvements on devices in general use, and many new inventions. As may be expected, the delegates and visitors will be the largest hitherto in attendance, including many government officials and representatives of foreign countries, besides many new railroad men, who have come into prominence since the last convention.

In accordance with the regulations, at the first session of the annual meeting the report of the Committee on Nominations announcing the names of the nominees for officers and the General Committee of the section shall be read. Elections shall not be held before the day after such announcement except by unanimous consent. The following is the order of business as arranged by the joint committees of the associated mechanical associations:

Wednesday, June 18, 9:30 a m. to 1:30 p. m. Prayer; address of welcome by the Mayor of Atlantic City; address by the chairman. Action on minutes of annual meeting of 1918 (M C. B.); report of secretary and treasurer (M. C. B.); appointment of committees on subjects, resolutions, correspondence, obituaries, etc.; unfinished business; new business; report of General Committee, including announcement of nominations for members of Nominating Committee; discussion of reports on nominations; standards and recommended practice (M. C. B.); train brake and signal equipment; brake shoe and brake beam equipment.

Wednesday, 3 p. m. revision of the rules

of interchange, including consideration of the following reports of committees: (1) Arbitration; (2) Revision of Prices for Labor and Material; (3) Depreciation for Freight Cars; (4) Revision of Passenger Car Rules of Interchange.

Thursday, 9:30 a. m. to 1:30 p. m. Discussion of reports on car wheels; standard blocking for cradles of car dumping machines; specifications and tests for materials (M. C. B.); welding truck side frames, bolsters and arch bars; couplers; draft gear.

Question proposed by members.

Friday, 9:30 a. m. to 1:30 p. m. Discussion on reports on safety appliances; loading rules; car construction; car trucks; train lighting and equipment; tank cars. Questions proposed by members.

Saturday, 9:30 a. m. to noon. Consideration of rules of order, election of officers, General Committee and Nominating Committee, presentation of badges to retiring officers, etc.

Monday, June 23, 9:30 a. m. to 1:30 p. m. Address of vice-chairman; action on minutes of 1918 annual meeting (M. M.); reports of secretary and treasurer (M. M.). Discussion of reports on standards and recommended practice (M. M.); mechanical stokers. Report of Committee on Powdered Fuel. Report of Committee on Tank Cars. Report of Committee on Specifications and Test Materials. Paper on "Standardization, by Frank McManamy. Questions proposed by members.

Tuesday, 9:30 a. m. to 1:30 p. m. Discussion of reports on fuel economy and smoke prevention; specifications and tests for materials (M. M.); design and maintenance of locomotive boilers; locomotive headlights; superheater locomotives. Paper on carbonization in valve chambers and cylinders of superheated steam locomotives, by E. P. Roesch. Amalgamation of other mechanical associations with Section III. American Railroad Association. Questions proposed by members.

Wednesday, 9:30 a. m. to 1:30 p. m. Discussion of reports on design, maintenance and operation of electric rolling stock, paper on the use of bronze for valve snap rings and piston surfaces, and for bull rings in large cylinders, by C. E. Fuller. Discussion of reports on train resistance and tonnage rating. Reports on subjects, on resolutions, correspondence, etc. Unfinished business; questions proposed by members and closing exercises.

Western Railway Club

At the annual meeting for the election of officers of the Western Railway Club, held in Chicago, Ill., last month, the following were elected: President, G. S. Goodwin, mechanical engineer, C., R. I. & P.; first vice-president, J. Purcell, assistant to federal manager, A., T. & S. F.; second vice-president, E. J. Brennan, superintendent of motive power, C., M. & St. P.; secretary-treasurer, J. M. Byrne, chief clerk to mechanical assistant, Central Western Region; directors, E. B. Hall, assistant superintendent of motive power and car department, C. & N. W.; L. S. Kinniard, superintendent of motive power, C. & E. I.; W. H. Flynn, superintendent of motive power, Michigan Central.

New Organization.

The International Association of Railroad Supervisory Foremen of Locomotive & Car Department has been organized with headquarters in the *Post Dispatch* building, St. Louis. The officers elected are: President, W. V. O'Neil, *Post-Dispatch* building; vice-presidents, John Beaton, 1226 Massasoit Ave., Chicago; John F. Crane, Terre Haute, Ind.; C. F. Petet, Denison, Tex.; J. L. Eckert, Chattanooga, Tenn.; D. Fulk, Spencer, N. C.; W. Tisdale, Philadelphia, Pa., and H. Louis Hahn, Albuquerque, N. M. W. F. Milligan is secretary and treasurer.

The membership embraces shop superintendents where no general foreman is employed, general foremen, assistant general foremen, foremen and assistant foremen, gang and hourly rated foremen who have supervision over mechanics; piece work and work inspectors, traveling boiler inspectors, traveling machinery inspectors, traveling car inspectors, traveling air brake inspectors and anyone traveling who has supervision over mechanics, chief interchange car inspectors, assistant chief car inspectors, chief joint car inspectors, wrecking foremen, all foremen of mechanics in maintenance of way department, chief draftsmen and foremen of drafting department.

Signal Meeting.

The Signal Division of the American Railroad Association, previously known as the Railway Signal Association, will hold its next regular meeting at The Breakers, Atlantic City, N. J., on June 26 and 27, 1919. H. S. Balliet, secretary, to whom all communications should be addressed in regard to the meeting, has removed his office from Bethlehem, Pa., to 75 Church St., New York., N. Y.

American Railroad Association.

The American Railroad Association, formerly with offices in the Transportation building, 608 South Dearborn street, Chicago, Ill., has leased the fourteenth floor of the Manhattan building, 431 South Dearborn street, Chicago, in conjunction with other railway associations which have been affiliated with the association.

Railroad Equipment Notes.

The Norwegian State Railways are reported as having ordered 16 locomotives from the Baldwin Locomotive Works, and as having placed orders in this country also for a quantity of car wheels and axles..

Forty locomotives of "mountain" type are being built in the United States to the order of the South African Government Railway Department, reports the British and South African *Export Gazette*.

Orders have been received by the American Locomotive Co. for 150 Consolidation type locomotives for the Italian State Railways. Each engine will have a total weight of 149,600 pounds; weight on drivers, 132,000 pounds; cylinders, 21¼ by 27½ inches.

An order for 150 freight locomotives, valued at $6,000,000, has been received from the Italian Government by the American Locomotive Company. The locomotives are duplicates of 250 engines previously furnished Italy by the same company.

The Pittsburgh, McKeesport & Youghiogheny has accepted 194 of the U. S. R. A. 70-ton gondola cars built by the Pressed Steel Car Company, making a total of 500 of these cars which it has accepted. These are the only standard cars accepted during the three weeks ended May 10.

The Pennsylvania Equipment Company, 1420 Chestnut street, Philadelphia, Pa., is in the market for several electrically lighted passenger coaches of modern construction, with toilets and water tanks, seating capacity of 48 or more, and weighing about 15 tons. The coaches must operate around a 28 deg. curve.

The United States Railroad Administration continued to deliver a considerable number of locomotives to the roads under Federal control, but it is noticeable that the total, including those furnished to other roads not under Federal control, fell short of the number furnished in previous months. In March there was a total of 250 as compared with 233 during April. This does not include over 100 locomotives furnished to foreign countries. It is also noticeable that the Mikado type of locomotive continues to lead all others in point of popular favor, the record during April showing that 61 of this type were placed in service, the next in numerical succession being the Santa Fe, 45; switchers, 34; Mallet and Mountains, each 19; Pacific, 10, and 1 Consolidation. It may be added that in addition to the above the American Locomotive Company during April completed 28 foreign locomotives, and the Baldwin Locomotive Works completed 8 foreign locomotives. Up to the same date the number of cars placed in service approached 28,000.

Bulletins, Catalogues, Etc.

The Railroad Problem.

Samuel Rea, president of the Pennsylvania Railroad system, delivered an address at the seventh annual convention of the Chamber of Commerce, St. Louis, April 30, 1919, and the address now appears in pamphlet form. He rightly believes that the rehabilitation of the railroads should begin at once, and that it is admitted by the vast majority of our thinking people that Government ownership and operation of the railroads are undesirable, and that individual enterprise has given, and will give, the public the best and cheapest service. It is also admitted that it is in the public interest that the capital required for enlargement of transportation facilities should be voluntarily furnished by private investors under the attraction of a satisfactory rate of return and degree of safety.

The Government and the Railroads.

Frank H. Fryant has joined the great army of those who know what to do with the railroads, and an article from *The Unpopular Review* from his pen is reprinted in pamphlet review. Mr. Fryant shrewdly states that the Republican party was evidently eager to go before the country in opposition to state socialization of industry, but shrewd Democratic leaders saw which way the wind was blowing, and almost overnight Government ownership was found to be without any real support as an issue between the great parties. The Democratic press is now pointing out that the party never was a Government-ownership party, and that it was the wily Republicans who were trying to force the issue, and now the President announces himself as in favor of giving the railroads back to their original owners at the new year. It is a good time to settle up accounts.

Catalogues and Trade Publications Wanted.

Commercial Attaché Chester Lloyd Jones has arrived in Madrid, Spain, and opened his office in the American Embassy. He would be glad to receive from American manufacturers and exporters copies of their catalogues, with price lists and other pertinent information. Publishers of trade journals who will furnish the attaché office with their publications are assured that they will be utilized freely. Catalogues and trade publications should be addressed to "The Commercial Attaché, American Embassy, Madrid, Spain." It will be of advantage to manufacturers of railway supplies to furnish all available information.

Staybolts.

The latest issue of *Staybolts* published bi-monthly by the Flannery Bolt Company, Pittsburgh, Pa., contains an interesting history of the development of the flexible staybolt. It appears that experiments were made forty years ago on European locomotives, but little progress was made owing to the defective forms in which the device appeared. Incrustation paralyzed the efforts of the early designers until the matter was taken up by the American engineers. The real success of the Tate flexible staybolt came from the fact that it contained the second head bolt, with ample clearance in the cap of similar shape and a tapered hole in the sleeve to prevent the bolt from becoming rigid by the accumulation of scale. The ample clearance in cap and sleeve insures freedom of movement in the variable expansion of the sheets.

Graphite.

The *Graphite* for May explains very clearly why Dixon's Graphite pipe joint compound makes threaded joints gas-tight. It is made in paste from selected flake graphite and a vehicle the result of many years' experience. It is much used by the largest railroads and gas companies. Threads can be screwed up a little more than with any other compound, and the fineness of the graphite allows it to fill up the little cracks in the threads, making a very tight joint. Acids and alkalies have no effect. Hence there is no rust. Heat under 1,500 deg. F., does not burn it. Threads of joints smeared with it are readily unscrewed.

Railway Operating Data.

The Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., are issuing illustrated leaflets containing operating data for the use and assistance of electric railway operators in the car and maintenance of car equipment. The methods suggested have proved to be economical and practical. Information as to what is being done elsewhere is always of value, especially when the supply of new data is maintained. The leaflets will be continued, and older ones superseded as occasion requires. Duplicate copies of those already issued may be obtained on application, and it is recommended that copies be framed and placed in shop departments where they will serve as permanent instructions for the workmen.

Wood's Catalogue.

Wm. H. Wood, hydraulic engineer, of Media, Delaware Co., Pa., is issuing a new catalogue of 63 pages, which embraces all kinds of hydraulic machinery and improved locomotive boilers.

The League of Nations.

The Commonwealth Steel Company has made a new departure in the latest issue of the *Commonwealther* by devoting an elegant supplement of 18 pages to a reprint of President Wilson's addresses in his European tours from December 25, 1918, to February 14, 1919, and also additional speeches at Boston, Washington and New York during February and March of the present year. The publication also contains the 26 articles of covenant of league of nations. The paper and presswork are of the best. The regular issue maintains its high standard of literary and pictorial excellence.

Aluminum.

The Bureau of Standards, Department of Commerce, Washington, D. C., has issued circular No. 76, setting forth the physical properties of aluminum and its light alloys. The details of the manufacture operations are described, with particulars in regard to temperatures, weights, resistance and other properties. Copies may be had free on application.

American Society of Mechanical Engineers.

The spring meeting of the American Society of Mechanical Engineers will open at the Hotel Statler, Detroit, Mich., on Monday, June 16, and close on Thursday, June 19. The programme includes the presentation of papers on "Industrial Research," "Industrial Peace," "Gas Power Engines," and on Thursday, June 19, miscellaneous technical papers, one of which will be for the discussion of fuels, including powdered fuel and oil fuel.

Wayne Tool Mfg. Co. Extends.

The Wayne Tool Mfg. Company, formerly the H. T. Shearer Machine Company, of Waynesboro, Pa., have recently opened their plant No. 2, at Waynesboro, in which they are manufacturing bridge and boiler reamers exclusively. Their staff of engineers have made important improvements on specially designed machinery for the manufacture of these reamers and expect to raise their capacity to 600 reamers per day within the next few weeks. The company can fill all orders promptly in the future.

Chicago Union Station

Commissioner of Public Works Francis announces that work will be resumed in proceeding with the completion of the new union station. It is expected that over 1,000 men will be engaged in June, and this number will be added to as material is secured. The federal government and city officials promise that every assistance will be rendered looking towards an early completion of the work.

Edison Medal.

Benjamin G. Lamme, of the Westinghouse Electric & Manufacturing Company, has been awarded the Edison medal which is given yearly for meritorious achievement in electrical science or electrical engineering. The presentation was made by William B. Jackson, vice-president of the American Institute of Electrical Engineers in the auditorium of the Engineering Societies building, New York. Mr. Lamme, who served during the war as a member of the Naval Consulting board, received the medal for inventions and developments of electrical machinery.

Railroad Employees.

It is interesting to note from the statistics that the number of employees on the railroads under Federal control at the end of 1917 were 1,703,684, and at the end of 1918 had increased to 1,843,530 or about 8 per cent per year. The total estimated pay roll for 1918 amounted to $1,822,794,000.

Railway and Locomotive Engineering

A Practical Journal of Motive Power, Rolling Stock and Appliances

Vol. XXXII | 114 Liberty Street, New York, July, 1919 | No. 7

Pennsylvania's New Simple Mallet Type Locomotive

A special exhibit that attracted much attention at the mechanical convention at Atlantic City, N. J., last month was a Mallet locomotive of the simple type, and of unusually large proportions, which had just been completed at the Juniata shops of the Pennsylvania Railroad. Among other novel features the valve gearing is designed to effect the maximum traction effect with a cut-off varying from 25 to a maximum of 50 per cent., instead of the common range of cut-off from 25 to 90 per cent. This, it is claimed, effects considerable economy in the use of steam and may be the forerunner of a general adoption of this limit of cut-off in certain types of locomotives.

The boiler is of the Belpaire type, the barrel courses being 1 5/16 ins. in thickness, the outside diameter of the first ring being 96 ins. The grate area extends to 112 sq. ft., having a length of 14 ft. and a width of 8 ft., with a combustion chamber extending to 12 ft. 5½ ins. in length, with flues 19 ft. in length. The firebox sheets are butted and electric welded. There are 137 flues 2¼ ins. in diameter, and 284 flues 3¼ ins. in diameter, the larger flues containing the superheater tubes. The superheater has three vertical headers, and two superheater steam headers, and one central saturated steam header, each header being connected to from two to five units, each unit leading and returning to or from one of the larger flues. The locomotive is equipped with a Duplex stoker and a Franklin power grate shaker.

The length of the boiler, including smoke-box, being 53 ft. 9½ ins., and the crown sheet being over 26 ft. in length and being of a slightly upward slope towards the front, provision has been made for obtaining the correct water level while the locomotive is operating on grades, the gauge cocks being connected to ⅜-in. copper pipes traversing into the boiler through the wrapper sheet at the front end of the combustion chamber at various points and carried back outside the boiler to a point inside the cab, where the gauge cocks are attached showing the height of the water at the front end of the crown sheet over the combustion chamber. Another device shows the level of the water at the central point of variation.

FRONT VIEW OF PENNSYLVANIA MALLET BUILT AT JUNIATA SHOPS

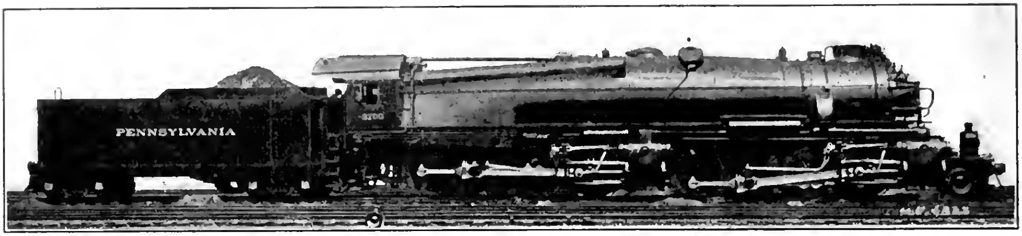
Another ingenious device is an auxiliary

method of admitting steam to the cylinders when the locomotive is standing in order to assist in starting. This consists of an extra port opening ⅛ in. wide by 1½ in. in length opening in the valve chamber bushing, and admitting the steam into a recess cut in the inner edges of the valve chamber steam ports. When opened, sufficient is allowed to accumulate in the cylinders to move the pistons and open the main port, and at certain positions of the main cranks, are of real service in facilitating the starting of the engine.

The locomotive is equipped with the Westinghouse E-T equipment in brake gear, furnished with four 16-in. by 12-in. cylinders, supplied by two 8½-in. cross-compound pumps, attached to the front end of the smoke-box.

The general dimensions of this locomotive are as follows:

Cylinders, diameter, 30½ ins. by 32 ins. Valves, piston, diameter, 12 ins.; greatest travel, 6 ins.; outside lap, 2 ins.; inside lap, ⅛ in. Wheels, diameter, outside tires, 62 ins.; driving journals, main, diameter, 13 ins.; length, 16 ins.; driving journals, 11 ins. by 16 ins.; engine truck wheels, diameter, 33 ins. Boiler, working pressure, 205 lbs.; diameter of first ring, 96 ins.; firebox, 168 ins. by 96 ins.; firebox plates, thickness of tube and combustion chamber connection, ½ in.; door, ⅜ in.; others, 7/16 in.; firebox, water space, 5 ins.; tubes, 137; diameter, 2¼ ins.; 284, diameter, 3¼ ins.; length, 19 ft. Heating surface, tubes and flues, 6,125 sq. ft.; heating surface, firebox, 531 sq. ft.; heating surface total, 6,656 sq. ft.; superheater heating surface, 3,136 sq. ft.; equivalent heating surface, 11,360 sq. ft.; grate area, 112 sq. ft.; tractive effort, 135,000 lbs.; weight in working order, 575,000 lbs.; weight on drivers, 540,000 lbs.; weight on leading truck, 35,000 lbs.; weight of engine and tender in working order, 794,000 lbs.; wheelbase, driving, 17 ft. 1½ in.; wheelbase total, 54 ft. 8½ ins.; wheelbase, engine and tender, 97 ft. 3¾ ins. Ratios; Weight on drivers ÷ tractive effort, 4.0; total weight ÷ tractive effort, 4.3; tractive effort × diam. drivers ÷ equivalent heating surface, 736.81; equivalent heating surface ÷ grate area, 101.41; firebox heating surface ÷ equivalent heating surface, per cent., 4.7; weight or drivers ÷ equivalent heating surface, 47.5; total weight ÷ equivalent heating surface, 50.6; volume equivalent cylinders, with 90 per cent. maximum cut-off, 43.6 cu. ft.; equivalent heating surface ÷ vol. cylinders, 260.0; grate area ÷ vol. cylinders, 2.6. Service, freight. Fuel, bituminous coal.



PENNSYLVANIA MALLET WITH INTERESTING NEW FEATURES

American Railroad Engineers' Work in France

The return of Brigadier General W. W. Atterbury, who had been serving as Director General of Military Railroads in France, has called particular attention to the work of the American engineers, which has been so marked a feature in the part that the American forces took in the war. It should be borne in mind that the perfection of details shown in the mastery of the gigantic transportation problems was not a spontaneous war product. It took tangible shape in 1916 in the Mexican border expedition. The American army commanders knew that in modern campaigns the railroad must follow the army. Even before war was declared, a regiment of railroad engineers had been organized in Chicago along the lines that had been followed in the organization of later railroad regiments.

In June, 1917, the formation of nine new regiments of railway engineers was authorized and begun. The first regiment to leave for France sailed in June, 1917, and other regiments left in July and August of the same year. From the declaration of war until the signing of the armistice 1,970 officers and 81,211 men were enrolled into this branch of the service, and of these 1,758 officers and 67,423 enlisted men served overseas. At the time of the armistice provision had been made for increasing the forces by 768 officers and 49,000 men.

Col. Harry Taylor, in the summer of 1917, was appointed chief engineer in France as a temporary arrangement, until General Pershing had made his survey of transportation requirements. His report, cabled to Washington, asked for the most capable man that could be sent from America. Mr. Felton, who had been made Director General of Military Railroads, selected W. W. Atterbury, who was at that time vice-president of the Pennsylvania Railroad. Mr. Atterbury went to France and in October, 1917, was made Director General of Military Railroads in France with the rank of Brigadier General.

Under General Atterbury's supervision came all the standard and narrow gauge military railways. The American regiments of engineers were at first placed with the French and required to operate under French regulations, but in July, 1918, the first train run by Americans and operating according to American regulations ran between Gievres and Nevers.

In addition to the work of maintenance and repair, 937 miles of new line were laid and hundreds of buildings along the main lines and in the main ports were constructed, some of which have been described and illustrated in our pages, and the work still goes on as special tracks are required to supply the army of occupation in Germany.

As is well known, the American engineers have had charge of the inspection of the locomotives transferred from the railroads in Germany to the Allies in agreement with the terms of the armistice, and it may be of interest to add that the special engineering instructors called for service in Siberia are also Americans. These men were not officers of the United States Army, but were sent to aid the Allied forces in Siberia. Two hundred and eighty-eight of these instructors sailed in October, 1918, for Vladivostock, with their expenses paid by the Russian Ambassadors. More than one hundred of these instructors are still in Siberia.

Proceedings of the American Railroad Association

Section III. Mechanical (M. C. B.). June 18-21, 1919

The first annual convention of the American Railroad Association, Section III, Mechanical, was held at Atlantic City, beginning June 17, and ending June 25, 1919. The Railway Supply Manufacturers' Association had arranged as during the conventions of the Master Car Builders' and American Railway Master Mechanics' Associations in conventions in former years to exhibit railway supplies in the buildings on Young's Pier, and the display eclipsed any former exhibition of the kind not only in numbers but in variety of improvements while the exquisite finish of the exhibits was the theme of admiration. The exhibit was enhanced by the presence of many skilled mechanics being at work not only at the various machines but at welding, forging and other work. The exhibition halls were also gaily decorated while the rich upholstery and furniture gave an elegance to the display not surpassed by an international exposition.

The attendance, as was expected, was the largest on record of these conventions, and the degree of earnestness manifested was particularly gratifying. This was not to be wondered at as the delegates were under instructions by the various heads of the mechanical departments, to which they were attached, to report at length on the merits of the exhibits, as well as on the proceedings of the meetings, so it might be properly said that the meetings have taken on a new phase that lifts them to a higher region of intellectual activity.

C. E. Chambers, chairman mechanical assistant, Allegheny region, United States Railroad Administration, presided. Mayor Bachrach, of Atlantic City, in his address of welcome alluded eloquently to the part that the railroad men had taken in the war. Mr. Chambers in his opening address reviewed the history of the Master Car Builders' Association from its organization at Springfield, Mass., in 1867, up to the present time and the important work it had accomplished particularly on the standardization of parts. He also alluded to the efforts that had been made in the way of a consolidation with the other mechanical associations, and prophesied that after the return of the railroads to their owners no one would desire to return to the old order of things as a coalition of all the mechanical associations was what the leading spirits of the railway mechanical men had been hoping and looking for during the present century. Many excellent suggestions were offered in the chairman's address, and in conclusion feeling allusions to the memory of those members who had died since their last meeting. The long and faithful services of Joseph W. Taylor, secretary for 17 years, and Dr. Angus Sinclair, treasurer for 18 years of the American Railway Master Mechanics' Association, were particularly noted, the latter as probably one of the most generally known mechanical men in the United States.

At the conclusion of the chairman's address the minutes of the 1918 convention were adopted as printed, and the chairman reported that the Executive Committee had held several meetings and that every detail had been attended to and completed in regard to the transition to the new order that had been established.

General Committee.

A report from the General Committee embraced a condensed report of the various meetings held by the committees of the two associations from which it was learned that the various committees have been continued, and that no change in the personnel, outline of work or procedure had been made except that the secretary of the section will act as secretary of all committees. All members of the associations are transferred to the Mechanical Section of the American Railroad Association. The representative members will be appointed by the railroads as formerly, and others will be known as affiliated members of the Mechanical Section. All properties including funds, furniture, fixtures and records, are transferred to the American Railroad Association, and are subject to the orders of the General Committee.

C. E. CHAMBERS

Secretary's Report.

Annexed to the report of the General Committee was the report of the secretary, showing a membership of the Master Car Builders' Association of 1029, and the American Railway Master Mechanics' Association, 1047. Representative members of both associations numbered 442; affiliated membership, 1,085; life members, 108; total, 1,635. The balance to the credit of the Master Car Builders Association amounted to $10,503, and the Railway Master Mechanics' Association, $4,741.

Reports of Committees.

Committee on Scholarships.

Before the scholarship funds of the American Railway Master Mechanics' Association are transferred to the treasurer of the American Railroad Association, the committee finds that the scholarships at Stevens Institute of Technology are perpetual scholarships, and are the absolute property of the Association. In 1891 the sum of $5,000 was invested on four scholarships, and up to the present time fourteen young men have availed themselves of the scholarships. Latterly, in 1919, it was decided that in conjunction with the Master Car Builders' Association that the earnings on the bonds and securities of both associations be prorated among the holders of the four scholarships, providing a sum of approximately $500 a year for the benefit of the holders of the scholarships. Jos. T. Ryerson & Son, of Chicago, added to this two scholarships, providing for $300 each per year. The donors of the scholarships have agreed to continue this arrangement with the Mechanical Section of the American Railroad Administration. Two scholarships are now vacant. Several applications have been received, and it is expected that all scholarships of the Association will be filled during this coming year.

Nominations.

The committee on nominations for officers are members of the general committee, to serve for two years, placed in nomination the following

For Chairman, W. J. Tollerton, G. M. S., Chicago, Rock Island & Pacific. For Members of the General Committee, J. T. Wallis, G. S. M. P., Pennsylvania; T. H. Goodnow, S. C. D., Chicago & North Western; W. H. Winterrowd, C. M. E., Canadian Pacific; C. H. Hogan, A. S. M. P., New York Central; J. E. O'Brien, M. S., Missouri Pacific; A. Kearney, S. M. P., Norfolk & Western, and C. F. Giles, S. M., Louisville & Nashville.

To serve for one year. For Vice-Chairman, Jas. Coleman, S. C. D., Grand Trunk. For Members of the General Committee, J. W. Small, Mech. Asst., Southern Region; Jno. S. Lentz, M. C. B., Lehigh Valley; H. R. Warnock, G. S. M. P., Chicago, Milwaukee & St. Paul; C. E. Fuller, S. M. P., Union Pacific; Samuel Lynn, M. C. B., Pittsburgh & Lake Erie; A. P. Prendergast, M. S., Texas & Pacific, and Jno. R. Gould, S. M. P., Chesapeake & Ohio.

Standards and Recommended Practice.

The committee appointed by the Master Car Builders' Association to report on the above subject reported at length on a number of matters of detail, some of which embraced changes in lettering and marking of cars, standardization of pipe unions, standard friction draft gear recommendations in regard to the limitation of parts to be welded. The latter subject was referred to the committee on welding truck side frames, bolsters and arch bars. A number of corrections were made in the printing of previous reports, and in the course of the discussion that followed a number of excellent suggestions were made and referred to the proper committees and on which a consensus of opinion will be obtained by letter ballot.

Train Brake and Signal Equipment.

A lengthy report was submitted by the committee embracing a revision of the standard instructions on the maintenance of freight brakes. The revision is divided into ten parts embracing the following: test and repairs to brakes in terminal yards; test and repairs to brakes on shop or repair tracks with brake stencils in date; annual repairs to brakes with stencils out of date; cleaning, lubricating and testing triple valves. The revisions and methods of testing with illustrations of testing devices will be added to the books of instruction in due time, and the subject will assume a degree of clearness in the future that has been to some extent lacking in the past.

Brake Shoe and Brake Beam Equipment.

The committee in its report set forth that many suggestions had been submitted particularly in regard to improvements on No. 2 Brake Beam. In 1918, a completely detailed brake beam, built upon the results of 1917 letter ballot, appeared among the M. C. B. Standard Sheets as result of special Executive Committee action suggested in connection with the car equipment built by the Railroad Administration, it being evidently thought that a beam supposedly used on the 100,000 administration cars would be fit for adoption and that such large initial use of a beam would be a favorable beginning for any standard.

On account of the generally unsatisfactory situation, which has obtained in connection with the committee's work, particularly with regard to the adoption of a standard No. 2 Beam, it was the opinion of the committee that the difficulties or objections which have beset its work and have operated to keep the committee from making the desired contribution to the advancement in the state of the art should be reviewed not only for information but for the benefit of the committee in planning for its future work.

The various changes made in brake beams and brake shoes and their attachments during the last twenty years were fully reviewed in the report, with accompanying drawings, and the committee is on the point of soliciting from the representative members statements of any reasons for not adopting the procedure outlined as the result of the various changes, and hopes to recommend for adoption next year some fundamental and basic procedure in accordance with the 1918 layout. The committee was therefore not prepared to recommend for adoption a Standard Beam, that is, a beam having all of its detailed dimensions duly standardized, but plans to include in its reports, beams and parts thereof fully dimensioned for the benefit of any who may be concerned in such information, and to arrange for adoption next year.

The committee admitted that it had not in the past benefited by reason of much construction criticism, as the records show that its work has for the large part been simply unapproved. In order to make progress, the committee should, at least, benefit by the reasons for negative ballot, if definitely construction criticism can not be furnished. This matter will be covered in this year's letter ballot, and particular attention is being called to the matter looking to a final solution of the problem.

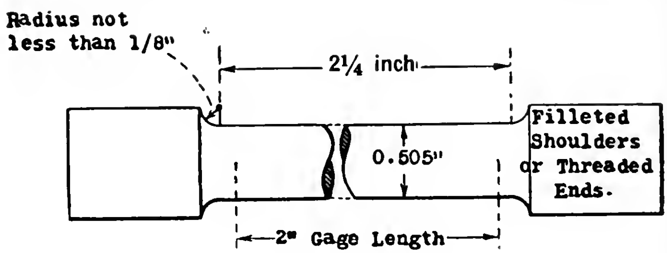


FIG. 1.

Depreciation for Freight Cars.

Replies were received from fifty-five railroads in answer to a circular requesting data on equipment dismantled during a period of three years ending December 31, 1917. This period was taken because it represented normal conditions more nearly than those during the first year of federal control. From the reports received it appears that the average life of all wood cars is 20.9 years, the scrap value, 13.5 per cent; all steel cars, average life, 13.1 years, scrap value, 12 per cent; railroad owned wooden refrigerator cars, 21.3 years. The committee favored having the trucks carry their own rate of depreciation and having that rate less for all-metal trucks than for composite trucks. In regard to rebuilt-cars this subject should be referred to a committee for consideration, and in the opinion of the committee in no case shall the depreciation exceed 60 per cent of the value new

Specifications and Tests for Materials.

A series of regulations in regard to the physical properties and tests of galvanized sheets was submitted by the committee, among other specifications being that the sheet material may be either open-hearth mild steel, or puddled iron made wholly from pig iron, and that all sheets shall be thoroughly cleaned and then galvanized with a coating of not less than 1.5 oz. of zinc per square foot. In regard to the tests of the material, it was specified that a test specimen shall bend twice in the same direction, first around a mandrel, the diameter of which is equal to fifteen times the thickness of the specimen, and

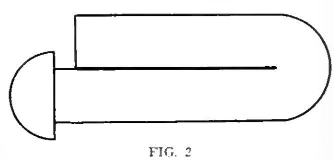


FIG. 2

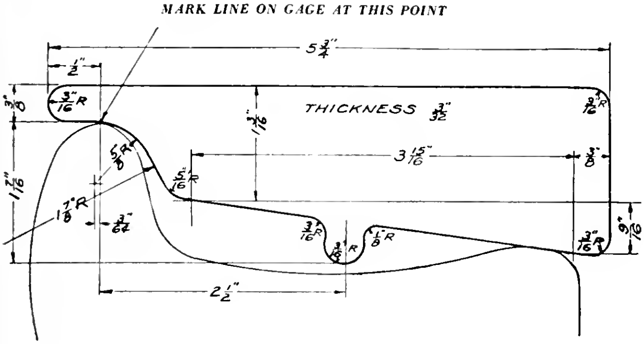
straighten, and then bend flat on itself and straighten, without cracking the base material.

In regard to the specifications for annealed carbon steel castings for passenger and freight equipment cars, the steel shall have a tensile strength of 65,000 lbs. per sq. in.; elastic limit, 0.4, tensile strength, and a yield point of 0.45 tensile strength, per sq. in. In the case of orders including only castings not exceeding 150 lbs. in weight, a test to destruction on one casting for each 100 castings or smaller lot may be substituted for the tension tests.

This test shall show the material to be ductile, free from injurious defects, and suitable for the purpose intended. A tension test specimen shall conform to the dimensions as shown in the annexed figure 1, the ends of which shall be not less than ⅞ in. in diameter and of a length and form to fit the holders of the test machine in such a manner that the load will be axial. Castings rusted to any extent, or covered with any material to hide defects, shall be rejected. In the requirements for rivets, the rivet shank shall bend cold through 180 deg. flat on itself, as shown in the accompanying figure 2, without cracking on the outside of the bent portion.

Car Wheels.

The use of the 38-in. car wheel, should, in the opinion of the committee, be discouraged, owing to the fact that the number of wheels of this diameter manufactured is small, and that in many cases



DETAILS OF WHEEL TREAD WORN HOLLOW GAUGE

the 36-in. wheel could be used. The committee found that owing to the vagueness of the rule in regard to the tread of a car wheel worn hollow, many wheels are being withdrawn on account of tread wear without the wear being sufficient to injure the wheel. A guage was recommended, as shown in the accompanying drawing, in determining whether or not a wheel should be condemned on account of tread worn hollow, a wheel not to be condemned on this account unless the projection on the underside of the guage does not come in contact with the tread of the wheel.

Draft Gears

Last year C. B. Young, manager, Inspection and Test Section, Division of Operation, United States Railroad Administration, advised it is the desire and intention of that section to make an extensive test of draft gears to determine what a draft gear should be, and also the value of the draft gears now on the market, measured by the ideal standard, and invited suggestions and recommendations of the Draft Gear Committee, Draft Gear Manufacturers and Railroad Officers. The committee acted upon this invitation and placed at the disposal of the Government all the data and tests that had been collected, as well as their views in connection with the tests to be conducted. After outlining their plan of procedure, the Inspection and Test Section of the United States Railroad Administraiton conducted tests of draft gears on the static and drop test machines, for the purpose of calibrating the gears that will be used in the cars at the Symington Testing Plant, which latter tests has been started, and to which your commitee has been invited. In order to avoid duplication of work and entailed expense, the committee has suspended making any tests of draft gears, but will work in close harmony with the United States Railroad Administration, Inspection and Test Section, and thus have available the results of these tests for the committee work.

Safety Appliances

From the committee's report it appears that on March 31, 1919, there were 2,372,768 freight cars, of which 2,283,123 were equipped with safety appliances, leaving 89,645 remaining to be equipped, or 3.8 per cent of the total. The report of each particular region was given showing that a number of roads mostly on the middle region were completely equipped with safety appliances, or nearly so. In the discussion that followed the presentation of the report it was pointed out that the law defines that after September 1, 1919, no cars shall be received in interchange unless so equipped. The only cause of delay in the matter of complete equipment seemed to be in getting the cars home where they belong, and a general desire was expressed to ask the Interstate Commerce Commission to extend the period calling for complete equipment until January 1, 1920. It was also suggested that it would be much more economical to make the needed additions of equipment at the points wherever the cars happened to be. It was further suggested that cars should be sent home loaded in all cases, as it is just as easy to load one car as another. The chief of the bureau of safety was in favor of equipping the cars wherever they happened to be. It was also called to mind that many of the most skilled of the mechanics had been busy putting safety appliances on the cars, but now that they were rapidly returning the home work would go on more rapidly. The lack of material was also referred to, especially in regard to the end ladders and coupler heads, and an extension of time in regard to these latter details was discussed at some length, but no action was deemed necessary, the Commission being expected to act favorably on the matter.

Loading Rules

The committee were in receipt of a number of recommendations and suggestions from the Regional Directors, the car service of the United States Railroad Administration, and others, relative to new rules to cover details of loading of material not taken care of in the present code of loading rules, including changes in the present rules. A number of new rules and modifications were incorporated in the rules as revised in 1918, including details in regard to the loading of automobiles, auto trucks, the securing of wheels to the floors of cars, truss blocking, double deck blocking, three-leg butting, and other means and methods of special loading, all of which will be incorporated in the code of loading rules at an early date.

Car Construction

Among other details, embodying amendments to the code of rules, the committee suggested provision for side door openings 10 ft. wide in all box cars, the side door proper to be 5 ft. wide, with a removable door post, and an auxiliary door 4 ft. wide. The traffic manager of the General Motors Corporation suggests the following for box car side doors: "It has long been my contention that a 6-ft. wide side door, with a movable post, and a 4-ft. extension beyond, is the proper kind of a door to be used on either 36-ft., 40-ft. or 50-ft. cars. This kind of door enables everyone to use a box car. In other words, with only a 6-ft. door it confines the use of this box car to certain commodities, and certain other commodities, such as light and bulky articles, are excluded from the use of these cars, as it is impossible to get a light and bulky commodity in anything less than an 8-ft. wide side door—10 ft. wide preferred. If all box cars in future were equipped with the kind of a door above described, it would mean that on a car coming into our factory, loaded with any kind of commodity, when this car was unloaded we could immediately use this car for loading automobiles or trucks, by removing the post and taking advantage of the 4-ft. additional exten-

sion. This, you will note, gives a load to the car in both directions, and means that there will be practically no empty movement of a box car in any direction, as the same could be used for all classes and kinds of commodities from merchandise to grain."

The point raised in the above is a matter of policy, for adoption or rejection by the management of the railroads. It, however, raises the question of providing a satisfactory design of door openings, wider than 6 ft., as a basis of construction. Special automobile cars with side door openings varying in width from 8 to 12 ft., and some with end doors 8 ft. and more in width, are in existence.

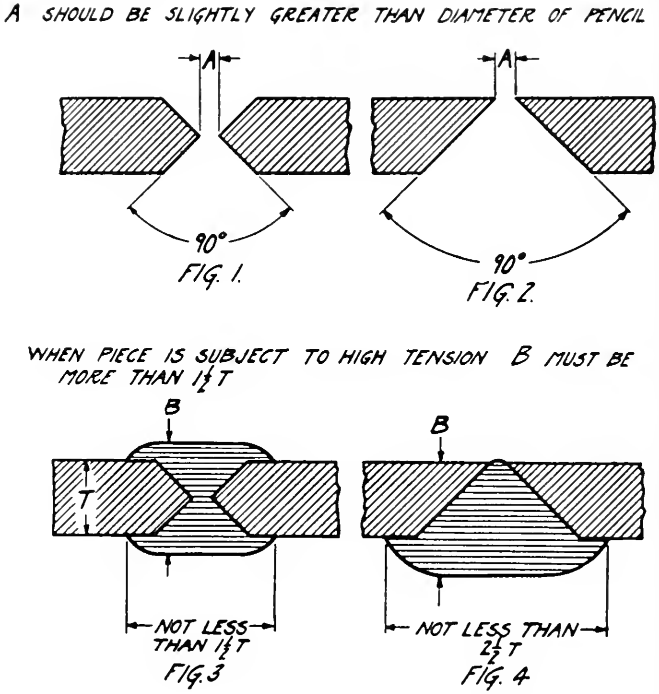
Letter ballots will be distributed in regard to numerous details, and the committee were continued.

Welding Truck Side Frames, Bolsters and Arch Bars.

The committee considered it desirable from the standpoint of economy and in the line of safety to retire cast steel truck sides and bolsters not conforming to the specifications, as rapidly as they show sign of failure; however, it is realized that this would entail a large expenditure of money and, therefore, it is believed that as an expedient autogenous welding should be permitted on these members within well defined limits and regulations. Worn surfaces may be built up, provided that the material remaining, in parts subject to high tension, such as hangers, etc., before welding, is equal to at least 80 per cent of the original section area, and in parts such as bolster guides, column castings and center plate rings, the material remaining must be equal to 60 per cent of the original section area. Broken coupler bodies, knuckles, locks, lifters and throwers should not be welded for the reason that reinforcing of the fractures can not be permitted on account of interfering with the proper operating of the parts. Worn coupler bodies, knuckles, locks, and throwers may be built up to the original sections, dressed and checked with proper gages to insure interchangeability and proper operation.

Welding cracks or fractures will be permitted on car and roof sheets, cast steel truck sides, pressed and structural steel truck sides, bolsters and transoms, cast steel bolsters, draft castings, brake beams, cast steel coupler yokes, car sills, ports, braces, carlines, side plates and end plates.

Welding is permitted only when the area of the crack is less than 40 per cent of the total area through the section at the point of fracture, but it is not permissible to weld any crack located within 6 ins. of an old weld. The edges of pieces for welding must be prepared as shown in Figs. 1 and 2. If both sides of the fractured member can be worked upon, the fracture should be prepared as per Fig. 1, and where only one side of the fractured member is accessible, Fig. 2 should be followed. The entire crack should be burned or chipped out far enough back so that there will be no portion of the crack in the metal. Failure to do this permits the check or crack to work its way across the metal to the farther side, due to the constant vibration, even after the weld has been made. A hole may be drilled at the end of crack or check and chip or burn towards the hole. The surfaces where new material is to be deposited must be clean and bright and reasonably smooth and, therefore, if the surfaces are prepared by the burning process the surfaces must be finished by chipping before welding. Worn surfaces permitted to be built up to the original section by depositing of new metal thereon must first be made clean, bright and fairly smooth, and after the metal is deposited must be dressed to the required dimensions and gaged where necessary.



DETAILS IN METHODS OF WELDING SIDE FRAMES, BOLSTERS AND ARCH BARS

Couplers

To accomplish the universal use of the Standard coupler the committee recommended that it be made mandatory that all new cars built after a certain date be equipped with the M. C. B. Standard "D" coupler with 6 ins. by 8 ins. shank, and that after the present stock of 5 ins. by 7 ins. couplers is used, all future renewals will be made with the M. C. B. Standard coupler with 5 ins. by 7 ins. shank. On existing cars equipped with 5 ins. by 5 ins. shank couplers, the present type of coupler should be maintained except where cars are changed in the draft arrangement, when provision should be made for applying either the 5 ins. by 5 ins. or the 6 ins. by 8 ins. shank M. C. B. Standard "D" coupler. It is impracticable to apply the standard "D" coupler to the 5 ins. by 5 ins. shank.

The committee further recommended that cars built after June 1, 1920, will not be accepted in interchange unless equipped with 6 ins. by 8 ins. shank M. C. B. Standard "D" couplers. Existing cars, equipped with 5 ins. by 7 ins. shank couplers of the present types, when requiring coupler renewals, shall have 5 ins. by 7 ins. shank M. C. B. Standard "D" couplers applied. This rule to be effective when present stock of new and second-hand 5 ins. by 7 ins. shank couplers have become exhausted. Existing cars equipped with 5 ins. by 5 ins. shank couplers shall have the existing type of couplers maaintained in repairs. Where changes are made in the design of the draft arrangement, provision should be made for the application of either the 5 ins. by 7 ins. or 6 ins. by 8 ins. shank M. C. B. Standard coupler.

United States Railroad Administration, Division of Operation, Mechanical Department Circular No. 8 reads: Coupler

operating device to be of type directly connected to coupler knuckle lock without use of clevis, link, chain or pin and to be interchangeable with operating device on United States standard cars where possible. United States Safety Appliance Standards provide for uncoupling levers to be either single or double, and of any efficient design with prescribed dimensions for various types of uncoupling levers including those which employ clevices and link, and provide penalties for uncoupling levers not conforming to the detailed specifications. The M. C. B. Standard "D" coupler makes provision for both top and bottom operation, the latter being necessary for cars with low height of floors from rail and where it is desirable to keep all portions of the uuncoupling arrangement below floor line.

The committee recommended submitting to letter ballot the following: Coupler operating device for new freight cars and application of new design coupler operating device to existing freight cars must be of type directly connected to coupler knuckle locking-block or locking-block lifter without use of clevises, links, chain or pin and must conform to the detailed specifications prescribed in the United States Safety Appliance Standards.

Car Trucks

Under date of February 10, 1919, the secretary of the M. C. B. Association, at the request of the Car Service Section of the United States Railroad Administration, referred to the Committee on Car Trucks correspondence on the subject of marking freight equipment cars to show the load limit and requested the committee to make a report to be submitted to the Car Service Section.

Cars have been marked with varying capacities as follows: 40,000, 45,000, 50,000, 60,000, 65,000, 70,000, 80,000, 85,000, 90,000, 100,000, 105,000, 110,000, 115,000, 130,000 and 140,000 lb. capacity, notwithstanding that we have but five M. C. B. standard sizes of axles, as follows:

M. C. B. Standard Axle.	Journal Size.	Nominal Capacity. (Load.)	Total Weight. (Car and Load on Rail.)
A...	3¼ in. by 7 in.	40,000 lb.	66,000 lb.
B...	4¼ in. by 8 in.	60,000 lb.	95,000 lb.
C...	5 in. by 9 in.	80,000 lb.	132,000 lb.
D...	5½ in. by 10 in.	100,000 lb.	161,000 lb.
E...	6 in. by 11 in.	140,000 lb.	210,000 lb.

The above table is based on four-wheel truck cars—four axles per car. The loads for six-wheel truck cars—six wheels per car—would be 50 per cent greater than given in the table.

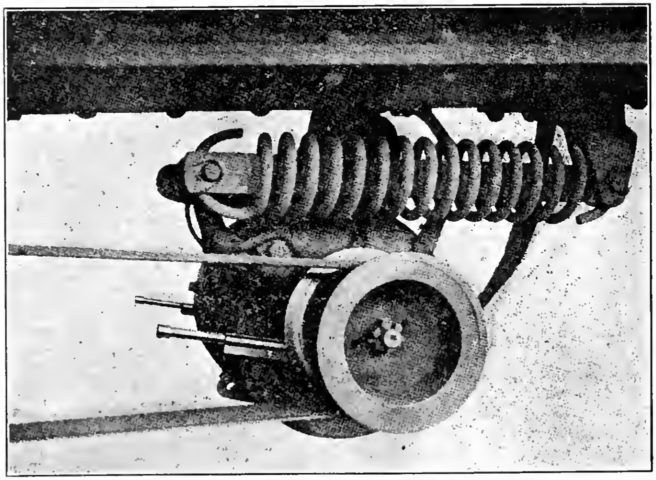
A number of recommendations were submitted in regard to the marking of cars, the riveting of bolts over nuts to the securing of spring plates, and other details, looking towards a standardization of the equipment. All of the recommendations will be referred to letter ballot for further action.

Train Lighting and Equipment.

The committee confined its efforts this year to developing a proposed standard basis for rating of car lighting axle generators and methods of testing to determine this rating. Some consideration was given to the subject of a proposed specification for axle generator car lighting equipment, but it was found impracticable to give sufficient study to the subject to be able to submit a report. There is not, at the present time, any method of rating axle generators, or of testing them to ascertain their rating, that has been accepted by any society or association. The various manufacturers have their own basis of rating and some few of the railroads cover the subject in their specifications, but there is no generally accepted method. In order that when quotations are received from axle generator manufacturers the purchaser may compare them on an equal footing, it appears essential that there be an officially recognized method of rating and of testing to determine the rating.

As satisfactory illumination and lamp life is dependent on an approximately constant voltage, it is obvious that the generator voltage should be maintained between as narrow limits as the range of charging voltage of the battery will permit. Also to maintain the voltage within these limits, it is apparent that the field strength must vary approximately inversely as the train speed, and therefore the maximum field current will be at the minimum train speed. As the heating of the generator is due principally to the energy dissipated in the fields and armature, the maximum heating must occur at an r. p. m. of the armature that will generate sufficient voltage to make the generator carry the current, and as the maximum temperature is limited, the object of a capacity test or heat run is to ascertain the maximum current that can be carried without exceeding this temperature limit, and this heat run must necessarily be made at the minimum r. p. m. that will generate rated voltage and current.

Details of a series of tests conducted by the committee were presented, and the report concluded with an opinion of the committee that a method of rating axle generators is one of the essential portions of an axle generator specification. The committee, while they realize that it is impossible to draw complete detailed specification that would be applicable to all types of axle generator equipment as now commercially manufactured, nevertheless believe that there are a number of essential characteristics that are common to all types of axle generators and which would be included in complete specifications. The committee therefore recommended that they be instructed to investigate this matter with a view to drawing up a partial specification which will include the features common to all axle generator equipment.



TYPE OF CAR LIGHTING GENERATOR

Tank Cars

With the war came the necessity for the transportation of various products, among them toxic liquids for filling shells, not previously handled in tank cars. The committee has given considerable time to the development of designs of cars for this purpose, principally in connection with the Engineering Division of the United States Ordnance Department. Some of the toxic liquids had low rates of expansion, so that the question of pressure was not material,

the one important requirement being that leakage must not occur. The Class III car was adapted to this service by the modification of certain details, such as omitting all openings in the shell, making the dome capacity about 1 per cent, special arrangement for closing the dome opening, etc.

While a design of safety valve was approved for use with a number of these cars, which it was important to get into service, there were some features of the valve which were not entirely satisfactory and study of the question, in connection with the representatives of the Ordnance Department, continued up to the time of the armistice, and has since been carried on by the committee.

The seams of these tanks were hammer welded throughout, using water gas as the heating medium. With steel of a proper quality there seems to be no difficulty in securing thoroughly sound welds and containers which are bottle tight. It is not certain that an absolutely tight valve can be secured which will at the same time retain the valuable feature of the present design, viz., very free discharge in case of necessity. A considerable amount of information has been accumulated concerning the behavior of safety valves under pressure, and the committee hopes to be able to push the work to a conclusion during the coming year.

Attention has been called to the injury of the shell of the tank by the use of chisel-pointed calking tools, and the committee recommends that a new sentence be added at the end of Section 4, Calking, Specifications for Classes III and IV Cars, reading, "Split calking shall not be permitted."

Your committee believes that as long as the requirements of the Master Car Builders' Standard Specifications covering the essential features of tank car construction are complied with it would be unwise to restrict the builders and users to certain standard designs, as the many commodities of widely different characteristics, weights and values transported in such cars require for their safe and economic handling various modifications in detail design. Specifications and prints have been furnished by the Railroad Administration for its cars, but the time available is entirely too short to permit the proper comparison and consideration of them and of the plans and specifications for other designs which must be gone over to answer the second question.

The committee were continued to complete the report on the questions remaining to more complete solution.

Election of Officers and Committees.

The officers for the American Railroad Association, Section III, Mechanical, was held on June 21, and resulted as follows: Chairman, W. J. Tallerton, general mechanical superintendent, Chicago, Rock Island & Pacific. Vice-Chairman, James Coleman, superintendent car department, Grand Trunk railway. These officers will serve for two years.

For members of the General Committee, term expiring June, 1921: C. F. Giles, Louisville & Nashville; T. H. Goodnow, Chicago & Northwestern; J. T. Wallis, Pennsylvania Lines; W. H. Winterrowd, Canadian Pacific; term expiring June, 1920: C. E. Fuller, Union Pacific; John R. Gould, Chesapeake & Ohio; John S. Lentz, Lehigh Valley; Samuel Lynn, Pittsburgh & Lake Erie, A. P. Prendergast, Texas & Pacific, St. Louis, Southwestern, International & Great Northern; J. W. Small, mechanical assistant to the regional director, Atlanta, Ga.; H. R. Warnock, Chicago, Milwaukee & St. Paul.

For members of the Committee on Nominations: F. W. Brazier, New York Central Lines; H. T. Bentley, Chicago & Northwestern; J. T. Wallis, Pennsylvania Lines; D. R. MacBain, New York Central Lines, and J. J. Hennessey, Chicago, Milwaukee & St. Paul.

Proceedings of the American Railroad Association

Section III, Mechanical (A. R. M. M.) June 23-25, 1919

W. J. Tollerton, who has been elected chairman of the American Railroad Association, Section III, Mechanical, and who also was serving as president of the American Railway Master Mechanics' Association, presided over what may properly be called the second division of the convention of 1919, the first division, as already stated in our report, beginning on June 18, and continuing until June 21, being devoted chiefly to the reports of the Master Car Builders' Association, and the second division taking up the reports of the American Railway Master Mechanics' Association, and such other matter as properly came within the scope of the work of the association. The meeting was called to order by Mr. Tallerton on the morning of June 23 and continued during June 24 and 25.

In his opening address the chairman reviewed the history of the Master Mechanics' Association, which had its origin in 1868 at Dayton, Ohio, and the locomotive of today may be said to be largely the result of the association's deliberations. Every detail of the locomotive had been considered and the recommendations looking towards improvement and standardization had been adopted. Its entire history has been a record of splendid achievement in the improvement of the steam locomotive in America, and the work will be carried on just as earnestly under the new organization which has been formed, and even better, because of the opportunity for a closer co-operation. There is still much room for improvement on the locomotive and roundhouses, and other requirements have not kept pace with the needs. A central testing bureau is a crying need which would have been in existence long ago if the Master Mechanics' Association had had the necessary means. Mr. Tollerton also paid a high compliment to the locomotive builders and the manufacturers of railway supplies, and expressed a debt of gratitude to the Railway Supply Men's Association, who had furnished excellent opportunities of inspecting all that was best in the supply department.

W. J. TOLLERTON

Standardization.

Frank McManamy, assistant director mechanical department, United States Railroad Administration, delivered an able address wherein he outlined the need of compulsory standardization of parts of railway appliances and the benefits arising therefrom. The matter had already been submitted to a committee composed of some of the ablest superintendents of motive power and mechanical engineers in the railroad business, together with the

engineers and designers from the locomotive builders, and the result had already been very gratifying. A number of types of locomotives has been standardized. Changes in operating conditions constantly emphasize the need of a more complete standardization in all the mechanical details of railroad operation to admit of a perfect system of interchange, and to this end the work would go on. Already the time lost at terminals, roundhouses, shops, and other periods of inactivity has been shortened. The same saving has been found in regard to the standardization of parts of the different types of cars. During the war period great steps had been taken in many directions, and none will last longer, be of more benefit, or give more satisfaction than the projected standardization of locomotives and rolling stock.

Fuel Economy and Smoke Prevention

The committee presented a lengthy report pointing out the importance of the subject and the marked progress that had been made during the war period in fuel economy, and alluded to the fact that various publications have recently pointed out, graphically and otherwise, the sources of heat losses in locomotive service, and these are doubtless well understood, but since a knowledge of the nature of these losses is essential to a proper appreciation of the possibilities for economy, it is desirable that brief reference be made to the avenues through which heat is wastefully dissipated, which are as follows: Steam leaks in fire box, superheater, front end or to the atmosphere. Grate, cinder pit and stack losses. Escaping steam through safety valves, unnecessary operation of auxiliaries, such as headlight generator, air pump, etc. Unconsumed volatile usually denoted by excessive smoke. Heat losses in escaping gases. Radiation.

In locomotive service the air supply is controlled by front end, flue, grate and ash pan conditions, which often do not receive proper attention from the designers. Many modern locomotives have grates with insufficient air-inlet openings, or with openings that readily become clogged, thus increasing the resistance to air flow. Attempts are frequently made to overcome this condition by adjusting front ends or reducing the diameter of the exhaust nozzle. Many of the older engines are still equipped with ash pans having insufficient air openings, a defect readily detected with a U tube draft gage. There should be no indication of vacuum in the ash pan. Correction of this condition recently permitted an increase of ½ in. in the nozzle diameter of several locomotives and not only effected a substantial saving in fuel, but greatly increased the efficiency of the locomotives.

A common source of loss of power and combustion efficiency arises from frequent unnecessary changes in the dimensions or adjustment of front end appliances. Standards suited to local conditions for each class of locomotive should be determined and maintained, and periodically checked by the inspection force. The common practice with respect to a poor steaming locomotive, for which the cause is not readily discernible, is to alter some of the front end details, whereas proper investigation usually discloses a leak in some of the joints, frequently between the front and the ring or around the outside steam pipe joints. As an overdrafted locomotive produces air, spark and back pressure losses, the importance of maintaining standard front end details may be understood.

A large part of the terminal losses arises from maintaining locomotives under steam when not required for early service and from unnecessary cleaning or removal of fires. Where locomotives are not likely to be required for service within twenty hours, as frequently occurs on Sundays or holidays, or under special conditions arising from variations in operation incident to reduced business, fires should be drawn. Under all circumstances grates and stacks should be covered to prevent the cooling effect of air circulation through the firebox and flues.

Design and Maintenance of Locomotive Boilers

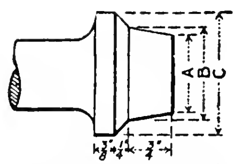
From the committee's report it appears that there had not been introduced any new or special designs of locomotive boilers during the last two years. About half of the roads reporting were using electric welding in fireboxes for patches, partial side sheets, cracks and fire-door patches. The roads having experience with combustion chambers report favorably on account of improved combustion and less trouble with leaky flues. A view of the combustion chamber is that its main function is not so much to increase the firebox surface as it is to shorten the tubes and give increased length of flameway, to allow combustion to be more nearly completed before it is extinguished by admission to the tubes. Combustion once completed, it is immaterial whether the heat be absorbed by the firebox or by the tubes, and the more heat extracted by the firebox, the less will be the evaporation of the tubes.

The attention of the committee was directed to detail description and reports of the performance of a locomotive equipped with new type of firebox on the C. M. & St. P. R. R., known as the "Nicholson Thermic Syphon." The principal features of design consist of two water legs extending longitudinally from the throat to the crown sheet, thus dividing the front end of the firebox into practically three chambers. These syphons are triangular in form from the side elevation, and constitute a water space about 4 ins. wide transversely, the two parallel surfaces being staybolted in the usual manner. The heating surface of this firebox in direct contact with the fire is materially increased, due to the area of these syphons. It is stated that the speed of the water through these syphons is such that all the water in the boiler passes through them in a period of five minutes. According to published test data, the engine equipped with these syphons appears to have produced some very economical results.

Specifications and Tests of Materials

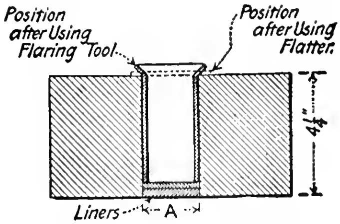
The committee furnished a number of exhibits and recommended that changes be made in accordance therewith. The changes referred particularly to specifications for lap-welded and seamless iron and steel boiler tubes, arch tubes, superheater pipes and safe-end materials, for which improved modifications were recommended. Specifications were also submitted in regard to air-brake hose jackets, tank and underframe rivet steel and rivets, also specifications for steel blooms, billets and slabs for carbon steel forgings, solid wrought carbon steel wheels, and steel castings for locomotives.

In the matter of flange tests, all tubes 6 ins. or under in diameter and having a thickness less than 9 per cent. of the outside diameter, a test specimen shall have a flange turned over at right angles to the body of the tube without showing cracks or flaws. This flange, as measured from the outside diameter of the tube, shall not be less than 15 per cent. of the outside diameter, but they shall in no case exceed ½ in. in width. In mak-



A = Outs. Diam. of Flue less 5/8"
B = Outs. Diam. of Flue less 3/8"
C = Outs. Diam. of Flue plus 3/16"

Flaring Tool.



A = Outs. Diam. of Flue plus 1/32"

Die Block

ing the flange test, it was recommended that the flaring tool and the block shown in the annexed figure be used.

The committee's report embraced also hydrostatic tests, standard weights, permissible variations, workmanship, finish, marking and numerous details, all shown in the exhibits, and much of the report embraced and emphasized the regulations recommended by the M. C. B. Committee.

Locomotive Headlights

The committee's report opened with a history of the evolution of the locomotive headlight from the time that the first arc light was operated in the early eighties by an oscillating engine, which was later changed into a turbine for furnishing the power, and this method, with modifications and improvements, is still in use. The report also embodied the data of the American Railway Electrical Engineers' Association, which contains a great deal of technical information and from which the following will be of interest as embodying several of the recommendations of the committee:

1. Recommend that an incandescent electric headlight be adopted with a 500-watt turbo generator, capable of developing 32 volts with full load on at a steam pressure of 125 lbs., governor to regulate speed of turbine properly between steam ranges of 125 to 200 lbs. 2. Recommend that manufacturers of electric headlight equipment adopt a universal standard size of ball bearing which will be interchangeable and can be purchased on the open market. 3. Owing to the transfer of motive power to foreign territory, the method of mounting the turbo generator should be standardized to facilitate interchanging of equipment. Recommend that the spacing of bolt holes for mounting the turbo generators be the same on all makes of equipment, and that the thickness of the legs of the turbo generator be standard so that standard size stud bolt can be used. 4. The turbo generator shall be located on top of boiler as near the cab as practicable, with the dynamo end toward side of boiler equipped with conduit system (preferably the left or fireman's side of the locomotive). Where locomotive conditions will not permit location of the generator set at this point, it is recommended that the turbo generator be located on the left side and longitudinally with boiler, the turbine end toward the locomotive cab and in a position as not to obstruct the vision of fireman. Under no condition should the exhaust pipe of turbine be attached in any way to the cab. Where it is necessary to place the equipment forward of center or at front end of locomotive, a ¾-in. extra heavy pipe should be run under lagging next to boiler for steam supply (this to prevent steam condensation or freezing of this pipe in severe weather), recommend that turbo generator be secured to boiler with ⅞-in. standard thread stud bolts.

The conduit system and wiring for electric headlight equipment on locomotive boiler shall utilize the hand rail where possible. The wires from turbo generator set shall run to cab and to front end of locomotive in hand-rail conduit (preferably on left or fireman's side). This hand rail shall be of standard galvanized electric-conduit of not less than 1 in. inside diameter.

Recommend that a 15-watt S-17-34 volt special cab lamp be used in cabs, signal or engine number lights, and all other outlets other than the headlight lamp. Recommend that a 250-watt G-30-32 volt concentrated filament lamp be used for headlight on road engines. Recommend that a 100-watt G-25-32 volt concentrated filament lamp be used on switch or back-up service engines. The committee recommends that a book of instructions on Maintenance of Electric Headlight Equipment be compiled for the guidance of headlight maintainers.

A sub-committee is now compiling this book of instructions.

Superheater Locomotives

The shortage of labor and material caused by the war has, in common with other appliances, delayed the superheat schedule. The committee reported, however, that practically all railroads are applying piston valves when superheating, either by changing to piston valve cylinders or applying a piston valve steam chest.

On the railroads using slide valves no change was made in the oiling or lubricating devices when bronze valves were used, but where the original cast-iron valves were used some trouble with cutting the seats was experienced and the application of an additional system of graphite lubrication stopped the trouble. The hydrostatic lubricator is still the standard for all locomotives and results from same are satisfactory in most cases. A number of the railroads have taken up the force feed lubrication, using a plunger type of lubricator. As this practice of lubrication is very recent and data as to the performance limited, the committee does not feel justified in making any recommendation, but it is the opinion of the railroads using them that the force feed lubricator when in good condition will distribute the oil more economically, positively and regularly than the hydrostatic lubricator. It has the advantage of being outside of the cab and requiring no special attention of the engineman, as the feeds are set and the lubricator stops feeding when the locomotive stops.

Considerable trouble has been experienced with cylinder and valve packing. Much of this trouble has been overcome by changing the design of the rings, which in most cases consisted of going from a ring, with a square cross-section, to a narrow-faced ring, by using a better grade of material, and by admitting steam to the cylinders while drifting. It is the opinion of the committee that two cylinder packing rings are ample for good service. The majority of railroads report satisfactory results from 50 per cent. lead, 50 per cent. copper mixture for piston rod packing. Very good results have been obtained from 74 per cent. lead, 20 per cent. copper and 6 per cent. nickel, and 80 per cent. lead and 20 per cent. antimony, especially when equipped with a hard grease piston rod lubricator, which adds greatly to the life of the softer packing.

When automatic or manually operated drifting valves or drifting throttles are not used, instructions have been issued to enginemen to drift with what is called a cracked or drifting throttle. It is essential that steam be supplied to the cylinders while drifting. Drifting valves are not essential, but desirable, especially in a mountainous country, as the steam can be supplied by cracking the throttle. Automatic drifting valves of a good design are valuable, as they eliminate the human element in furnishing steam for drifting.

The tools used to repair and maintain the units are those recommended by the Locomotive Superheater Company. When units are removed, the joints should be reground and individually tested before being replaced, and collectively after being replaced. A periodical test might be desirable, but the committee feels that it is not essential.

Most railroads have issued through bulletins or personally by the road foreman, instructions not to carry over two gauges of water; this, of course, depends on the water conditions of the locality in which the locomotive is operating. The use of a pyrometer will show the men the low temperature of the steam resulting from carrying high water; it will also show the effect the position of the throttle and reverse lever has on the superheat obtained. The majority of the roads prefer a wide open throttle with as short a cut-off as possible under the operating conditions. Some roads claim better results by using a longer cut-off and a lighter throttle, claiming better superheat.

Light, frequent and regular firing proves to be the best practice, and produces the best degree of superheat, but it is essential that at all times the flues be kept clean. The method of firing depends on the quality of fuel used.

Carbonization in Valve Chambers and Cylinders of Superheated Steam Locomotives; Its Cause, Effect of Lubrication and Maintenance, and Proper Measures to Overcome Same

An individual paper on the above subject was presented by F. P. Roesch, in the course of which he described the various devices that had been applied to locomo-

tives to overcome carbonization while drifting, and illustrated his subject by indicator diagrams showing the production of a vacuum under certain conditions and the pernicious effects of the same. Mr. Roesch is of opinion that on roads where no drifting occurs to speak of, i. e., comparatively level roads, the use of the drifting throttle, so called, will undoubtedly prevent the admission of smoke-box gases to the cylinders regardless of the presence or absence of either or both steam chest relief and cylinder by-pass valves, provided the engineer does not forget. Here, however, is the danger—human fallibility. If the engineer fails to leave his throttle slightly cracked when coming to a stop, or when tipping the summit of a grade, the damage is done even though the throttle be left closed for but a few revolutions. Each succeeding oversight adds its mite to the deposit, thus accounting for the deposits where the drifting throttle is presumably always used. As stated above, on comparatively level roads the drifting throttle can be used to advantage if men will at all times comply with instructions, but where necessary to make long drifts other means must be provided, as the drifting throttle is not always practicable, the grade, tonnage, brakes, etc., governing. The above explains why some roads find it to their advantage to block by-pass valves, while others maintain same presumably operative. In the absence of both by-pass and relief valves much higher compression and greater vacuum will obtain than by their use, and in this case the vacuum can only be relieved through the nozzle.

Here, then, apparently is where and when the trouble starts. As the cylinder pressure is less than atmosphere, air will flow in through the nozzle and the open exhaust port until the pressures equalize, the combined steam, air and smoke-box gases being then expelled by the piston on its return stroke. However, as the valve, valve chamber and ports are at their highest temperature and exposed to the first inrush of the incoming gases, it follows that all carbonaceous matter in these gases coming into contact with any of the above surfaces will adhere, or, in other words, be baked on. This theory appears to satisfactorily account for the greater deposits obtaining in the exhaust cavity of the valve, as well as the exhaust ports and passages.

The remedy appears obvious, namely, prevent by automatic means as far as possible the intake of smoke-box gases or neutralize their evil effects by diluting with steam. To accomplish this it would appear that we should turn to such devices as we already have at hand, viz.: the steam chest relief and the by-pass valves. While the former is not exactly necessary, yet its use under proper conditions presents no great difficulty and as a safety feature it has a distinct place. The use of the by-pass, however, is practically essential in that it will go far toward preventing the formation of a vacuum in the cylinders.

The last and most important requirement is the neutralization of such gases as might be drawn in through the nozzle through improper handling of the locomotive. This can only be accomplished by admission of a jet of steam to both the receiving and exhaust end of the valve, so that when the conditions obtain as mentioned previously, the steam jet so admitted will mingle with the front end gases before these gases have an opportunity to deposit their constituent matter, and so neutralize their effects, it being universally conceded that carbonization of oil, or even the deposits of the so-called carbon, will not take place in the presence of steam.

Design, Maintenance and Operation of Electric Rolling Stock, or the Heating of Passenger Trains Drawn by Electric Locomotives.

The early history of the heating of passenger cars and the numerous appliances experimented with was fully described in the report of the committee, beginning in 1902 and coming down to the present time, from which it appears that there were five types of oil-fired boilers, and four electrically-heated boilers. All of these embraced radical changes. The result of these experiments culminated in the construction of a larger boiler than had hitherto been experimented with in 1912. This type of boiler is 30 ins. in diameter, with 1,380 copper flues 30 ins. long, and

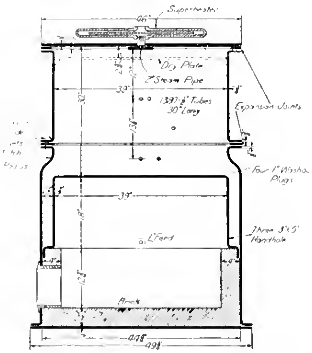


FIG. 1—CROSS SECTION OF BOILER USED IN HEATING CARS ON ELECTRIC TRAINS

½ in. in diameter, 156 sq. ft. of heating surface, a working pressure of 110 lbs., and a capacity of 2,200 lbs. of steam per hour. A cross-section of this boiler is shown in Fig. 1, and the fuel oil burner used is shown in Fig. 2. This is very simple, easily cleaned and adapted to eastern fuel oil, which has a paraffine base, or kerosene. It is worth noticing that the lower section of the burner, which carries the steam or air for atomizing the oil, projects beyond the oil orifice, forming a lip or shelf on which the excess oil may flow and still be atomized. Where it is more economical to use the heavy western oils having an asphalt base, it has been found necessary to leave off the lip, because of the liability of oil accumulating at that point and interfering with the steam jet, as shown by the ex-

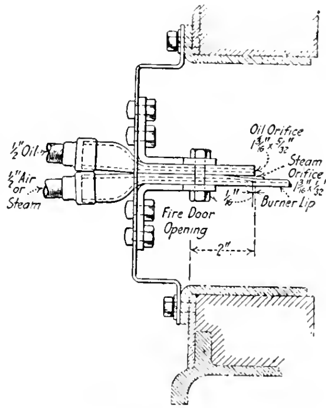


FIG. 2—BURNER ON PARAFFINE BASE OILS

perience of the Chicago, Milwaukee & St. Paul. Their burner is shown in Fig. 3. Only when the boiler is started is air from the main air reservoir turned into the stack blower to insure a draft and onto the burner to atomize the fuel oil. As soon as there is a steam pressure approximating 50 lbs., a three-way cock is used to substitute steam for compressed air. That only a very short time is required to obtain steam for this change is obvious when it is realized that with cold water in the boiler it requires only four minutes to develop a steam pressure of 10 lbs., and 10 minutes from starting the fire a steam pressure of 110 lbs. is obtained.

So far as the committee is informed, no practical steam boiler has yet been developed which uses electricity as a source of heat. Assuming that such a heating plant is available, there are certain facts which should be borne in mind. The cost of electricity to produce a given amount of steam is from six to ten times that of fuel oil, omitting the item of fixed charges in the cost of current. The ratio depends on the relative cost of fuels. If the peak load for propulsion and heating current come at the same time, during the Christmas holidays, for instance, it will be necessary to increase the power station and substation capacity, not only increasing the capital invested, but incurring additional fixed charges which continue during the whole year, though the additional apparatus is required for only a few months during the heating season. Estimates

made a few years ago showed that electrically generated steam would cost about $45,000 a year more than from oil-fired boilers, the number of locomotives involved being less than 35, not including fixed charges in the cost of current. If fixed charges are included, there would be in this case a saving of over $100,000 a season in favor of oil as a source of heat.

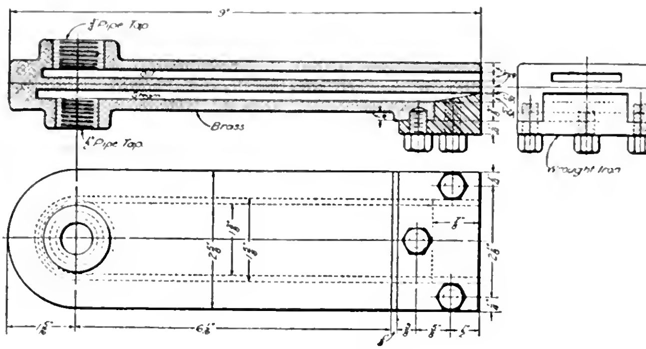


FIG. 3—BURNER FOR ASPHALT BASE OILS

The Use of Bronze for Valve Snap Rings and Piston Surfaces, and Bull Rings in Large Cylinders, to Prevent Rapid Wear and Cutting of Cylinder and Valve Bushings.

C. E. Fuller, superintendent of motive power, Union Pacific Railroad, presented an individual paper on the above subject, wherein he stated that at no other point on the locomotive can the losses become so great or so quickly aggravated, due to rapid cutting and wear. With this fact in mind the Union Pacific began experimenting some years ago with bronze valve snap rings, and bronze surfaces for pistons. The formula for the bronze valve snap rings consists of copper, 82.96 per cent.; tin, 14.66; phosphor, .118; impurities, 2.26.

Valve rings are of the usual L-section for 15-in. piston valves of cast iron, working in gun-iron bushings. Against 117 cast-iron rings, making 216,495 engine miles, there were 45 bronze rings, making 381,337 engine miles—an increased mileage in favor of the bronze ring of 358 per cent. A Pacific engine was equipped with bronze rings April 13, 1916; rings removed, worn out, March 22, 1918, with a mileage of 145,285.

In August, 1915, a Consolidation type engine with 22-in. cylinders was equipped with two cast-iron pistons having bronzed bull ring poured on while pistons were at about 1,500 deg. F.—afterwards machined to size, including ring grooves which were fitted with gun-metal rings. Frequent reports from this engine indicated that these pistons were performing quite satisfactorily, the rate of wear on pistons and cylinder walls being much below the average with cast-iron pistons. The bronze adhered to the piston head without fracture. In June, 1916, this engine was shopped—both pistons being reapplied to engine without any work being done on them—mileage 40,000.

The success of this experiment led us to adopt the bronze face, and ten engines so equipped were placed in mountain service in the fall of 1917. In six months the bronze had worn down to the cast-steel lip at the edges of the piston, between 1/32 in. and 1/16 in. Pistons were then reversed, and gave four or five months' additional service. Since then, from time to time, this cast-steel lip has been turned back slightly, exposing additional bronze surface, and at the end of 19 months several of these pistons are still in service, not having reached the limit of wear with their original bronze surface. The piston centers, however, are all intact and apparently capable of indefinite service. These pistons have made over 60,000 miles in most difficult service, and no cylinders have been rebored; in fact, showing remarkably little wear. Incidentally, the use of bronze permitted the adoption of a very light design of piston, which though 29 ins. in diameter, weighs only 544 lbs. complete, without rod.

Cast-iron piston heads, which heretofore have been scrapped on account of wear—which usually takes place mainly on the bottom half of the head—are now treated as follows: Pistons are preheated in a brick furnace over a charcoal fire to a temperature of 900 to 1,000 deg. F., without removing the rod. A small hole is then made through the sheet asbestos on top of the furnace over the piston, to permit the welding operator to work—the piston being turned from time to time by means of the rod as the work progresses. He first welds a thin layer of bronze over the worn surfaces between and adjacent to the ring grooves for approximately one-half of the circumference of the head; he then proceeds to build up to the desired height, including finish, after which the furnace is closed and the fire is allowed to die out and cool over night.

The piston is then machined, grooves squared up—and ready for service, being applied with the bronze shoe to the bottom of the cylinder. Tobin bronze welding rods are used—about 8-lb. average, per 26-in piston.

However, it is contemplated from our previous experience with the fully bronzed circumference, and particularly in view of the fact that most of the wear is at the bottom of the cylinder, that these reclaimed pistons will not only show a considerable increased mileage, but will also show a material saving in cylinder-barrel wear, thus increasing the mileage between reborings.

A 26-in. worn cast-iron piston can be treated in accordance with the above process for approximately $9.35, while replacements with a new piston of the same design would cost $27.86. This results in a saving of $18.51—besides resulting in really a better piston than the original on account of decreasing tendency toward wearing the barrel of the cylinder. Up to date about 50 pistons have been thus reclaimed and put into service, and there has not been a single failure reported.

By the use of bronze for valve snap rings and for piston surfaces, we have been able to materially reduce the rate of wear and increase the life of the cylinder and valve bushings, as well as the pistons, and keep locomotives longer in service with a maximum of power due to tight and properly fitting parts.

Powdered Fuel

At the time of the last report of the committee in 1916, there were several experimental installations for burning powdered fuel on locomotives in the United States, but the increasing demands for transportation, due to the great war, and finally the entrance of this country into the conflict, made the setting aside of even a single locomotive for such experimental purposes an impossibility. Accordingly all locomotives that had been equipped for the burning of powdered fuel were stripped of the special appliances intended for that purpose and returned to their regular service. It is for this reason that the committee asked to be relieved from making a report, even a report of progress, at this time. The general principles involved in the burning of powdered fuel were set forth in our last report in 1916, when the experiment were progressing so satisfactorily that they seemed about to spell success. That the principles were correct has been demonstrated and it remained to work out the practical details to meet the varying requirements that locomotive service demanded, as has been

done for stationary plants. But this sudden stoppage of the work, immediately after the presentation of our last report, leaves matters almost exactly as they were at that time.

It is probable that, as soon as the affairs of the railroads are settled and normal conditions have been resumed, the experiments with and development of the devices for burning powdered fuel will be taken up again, which it will then be the pleasure of your committee to present to you. And, with conditions as they are, the committee asked to be relieved from the necessity of making a report at this time and to be continued pending the resumption of the experimental work which they were appointed to watch and lay before the association.

Mechanical Stokers—3,717 Now in Service.

The Committee on Mechanical Stokers has been reporting to the Association since 1913. During the last two years, the railroads have done very little research or experimental work as all interests have worked with the one purpose in view of producing transportation, and other interests have been put aside for this end. Consequently, there has been practically no information established relative to the performance of locomotive stokers in service such as is obtained from specially conducted tests.

This two-years' war period, from a manufacturer's standpoint, however, has been extremely active, and there have been a large number of stokers applied. Inquiry was made of the different stoker manufacturers as to the number of stokers they had actually applied and were in service as of January 1, 1919. The following table indicates the number of different representative stokers then in service and the type of engines to which they have been applied:

Kind of stoker	Mallet	Mikado	Santa Fe	Centipede	12-Wheel	Decapod	Consolidation	Mt. Type and Mohawk	Pacific	Total
Street	424	638	380	4	14	....	22	3	37	1522
Duplex	246	804	195	....	....	53	1	1	....	1294
Standard	120	338	36	....	33	....	21	162	21	731
Hanna	70	6	73	....	16	....	....	4	....	169
Elvin	....	....	1	....	....	....	....	....	....	1
Total	354	1786	685	4	63	53	44	170	58	3717

There was a total of 3,717 stokers of the above types in service January 1, 1919. The stoker report of 1917 shows a total of 1,611 stokers (exclusive of Crawford) in service as of April 1, 1917. There have been placed in service 2,106 stokers between the dates of April 1, 1917, and January 1, 1919, which indicates the rapid rate at which locomotive stokers are being applied. The types of locomotives to which the stokers are largely being applied are the Mallet, Mikado and Santa Fe, which represent the locomotives of large capacity. The question as to the size of locomotives upon which stoker installations are justifiable is one that is frequently referred to and is yet unsettled. It is the opinion of your committee that the conditions surrounding individual conditions are so variable that no fixed rule can be recommended for guidance in this connection.

There were some questions of general interest in connection with stoker operation concerning which it was thought well to secure an expression from the roads using mechanical stokers. These questions were sent out to such roads and replies to this inquiry have been received from thirty-two roads; these thirty-two roads represent a total of 1,777 of the stokers now in service. Inquiry was made relative to the kind and character of fuel used, and it is noticed that on all of the roads bituminous fuel is used; the fuel reported varies in heat units from 9,212 B. t. u. to 14,250 B. t. u.

In answer to the inquiry as to whether the same size exhaust nozzles are used on stoker-fired locomotives as employed on hand-fired locomotives, it seems that the general practice is to use the same size exhaust nozzle, although a few roads vary from this general practice. Three roads report smaller nozzles on the stoker-fired locomotives, ranging from ⅛ in. to ¼ in. smaller in diameter. Two roads report that they are using nozzles from ⅛ in. to ¼ in. larger in diameter than are employed on their hand-fired locomotives.

In the report of 1917, additional reference was made to the Elvin stoker then undergoing development on the Erie Railroad. This stoker has passed through its experimental stage, and it is understood that it is now in condition to be presented as a commercial proposition. Your committee has learned from reliable sources that the Elvin stoker now in operation on the Erie Railroad is giving very satisfactory service, and that it embodies several individual features which may mean greater economy in mechanical firing. The opinion has been expressed by disinterested parties who have come in contact with this type of stoker and have seen it in operation that, while it may not have reached its final stage of development, there are, nevertheless, marked possibilities in a stoker of this type.

Bottom Outlet Valve on Tank Cars.

W. Gibbs, presented an individual paper on the above subject, wherein after discussing the general construction of the bottom discharge value on tank cars now in use,—generally consisting of a miter valve fitting into a conical seat, the valve being guided by either a pin passing through a hole in a bridge below the seat, or wings fitting a cylindrical hole forming the discharge passage below the seat, the material being either steel or cast or malleable iron.

Complaints have been made as to liability to corrosion, lodgment of foreign matter in the valve seat, cocking of the valve, displacement of the valve by the surging action of liquid contents of tank, and change of shape of the tank due to weight of lading causing lateral spreading.

The Chief Inspector of the Bureau of Explosives has suggested that the Tank Car Committee design a proper outlet valve arrangement, but it is felt that it is not advisable for the committee to devise such an arrangement and then push its adoption. We believe that there is ample talent among the engineers of the car building and car operating companies to provide adequate devices if they will give this feature the same attention that has been given to the improvement of the general construction of the tank car.

Calibration as Adjunct to Efficient Drawbar Pull—Speed—Cut-Off. Locomotive and Train Operation.

A very interesting individual paper was presented by B. B. Milner, Engineer of Motive Power, New York Central Railroad, in which he discussed very thoroughly the fact that with the same engine and the same train, some enginemen are able to handle trains over "tight" places, as ruling grades or other difficult places, to satisfactorily move trains, while others fail to do so. Some may run with a full throttle, some with a partially, some with a partially closed throttle, but the crucial test of performance upon the "tight" places usually occurs at speeds so low that the difference between a full throttle and partial throttle with which some men may operate under these conditions is—nil. However, the position of the reverse lever is a very important factor because it affects directly drawbar pull developed. There is for each speed, a cut-off, at which the drawbar full developed, will be a maximum and that the drawbar pull developed for any other cut off, either longer or shorter, will be less than that developed by the cut-offs which should be used in "tight" conditions, where the maximum drawbar pull is necessary.

A series of tests were made by having an engine coupled immediately ahead of a dynamometer car, then between the dynamometer car and the train, a second engine, the engine under test being run at a selected fixed cut-off, while the en-

gine next to the train and back of the dynamometer car was used for regulating speed. A series of tests of one engine was begun by placing the reverse lever of the forward engine under test in the first notch forward, and moving the train from rest at slowly increasing speed—the second engine regulating the speed by setting of brakes or by assisting, if necessary—until the speed attained was such as to cause the engine under test to fail for steam at, say 15, 18 or 20 miles per hour, dependent upon boiler capacity. The dynamometer car recorded the drawbar pulls developed throughout the range of speeds attained, from zero to the highest speed at which the locomotive under test failed for steam.

From a continuation of this experiment with the lever in different notches until the center is approached, it can readily be seen that exact data of the varying speeds and varying amount of drawbar pull can be accurately secured, and Mr. Milner prepared a series of charts which, in point of precision over a track of varying grade, are at once a reliable guide to conditions in actual service, and having determined the tonnage rating, what expected to make therewith, under conmovement may the given locomotive be ditions which require maximum performance.

The publication of the complete record of the tests in the form of cards or in otherwise convenient form would be of great value to enginemen, and something of this kind may be expected in the near future.

As one example of the tests referred to, it was found that a Mikado type engine, cylinders 25 by 32 in., driver diameter 63 in., carrying a steam pressure of 180 lbs., was found to develop greatest drawbar pull with reverse lever in notch one, or full cut-off, from start up to speed of 9 miles per hour; with reverse lever notch 2, or slightly shortened cut-off, at speeds from 9 to 10½ miles per hour; in reverse lever notch 3, or slightly further shortened cut-off at speeds from 10½ to 11½ miles per hour, with reverse lever in notch 4, or with cut-off further slightly shortened, at speeds from 11½ to 13 miles per hour, etc. With Consolidation type engine, cylinders 23 by 32 in., driver diameter 63 in., and steam pressure 200 lb., maximum drawbar pulls were found to be developed with reverse lever in notch one, or in the full forward position, from start to 9 miles per hour. At speeds from 9 to 11 miles per hour, maximum drawbar pull was developed with reverse lever in notch 2, or with slightly reduced cut-off; from 11½ to 14 miles per hour with reverse lever in notch 3; from 14 to 15½ miles per hour with reverse lever in notch 4, etc.

Combustion Chambers.

An individual paper of special interest on the above subject was presented on the last day of the convention by F. F. Gaines, chairman of the Board of Railway Wages and Working Conditions, United States Railway Administration, from which we quote the following: "A careful analysis of any locomotive boiler test reveals the fact that the firebox is the factor that limits both the boiler capacity and efficiency. In other words, boiler capacity and efficiency are limited by the amount of heat that can be liberated within the firebox, rather than by the amount of heat that can be absorbed by the heating surfaces.

"When burning high volatile bituminous coal more than 50 per cent of the heat generated is liberated by the burning of the combustible gases above the fuel bed, and in order to burn these gases, it is necessary to have ample combustion chamber space in firebox volume. The ratio of firebox volume to grate area has never received any careful or scientific investigation, but the value of firebox and combustion chamber volume is being demonstrated by the everyday operation of some 6,000 locomotives equipped with combustion chambers and is borne out by a few authentic tests, among which were units of two Pacific engines equipped with boilers that were identical in every respect, except that one had a 36-inch combustion chamber and 19-foot flues, while the other had the ordinary firebox with 22-foot flues.

"As the rate of combustion increased, the capacity and efficiency of the combustion chamber boiler showed a marked increase over that of the non-combustion chamber boiler, and while the non-combustion chamber boiler reached its maximum capacity at a rate of 130 pounds of coal per square foot of grate per hour, the capacity of the combustion chamber boiler continued to increase up to and beyond the rate of combustion of 160 pounds of coal per hour. At a rate of combustion of 120 pounds of coal per hour, the combustion chamber boiler showed an increase in efficiency and capacity of about 20 per cent, greater than that of the non-combustion chamber boiler, while at the maximum rate shown, the difference was more than 40 per cent.

"The combustion chamber firebox had a volume of 427 cubic feet, or a ratio of firebox volume to grate area of 6. The non-combustion chamber firebox had 311 cubic feet or a ratio of volume to grate area of 4.4. At a rate of combustion of 120 pounds of coal per square foot of grate per hour, the combustion chamber boiler gave an equivalent evaporation of 75,000 pounds per hour, which is equal to 2174 boiler horse power. Assuming that half of the heat was generated in the fuel bed and half above the fuel bed, we would have 1087 boiler horse power generated by the burning of combustible gases in a firebox volme of 427 cubic feet, or a generation of one boiler horse power per .4 cubic foot of firebox volume. At the same rate of combustion, the non-combustion chamber boiler evaporated 63,000 pounds per hour and developed 1826 boiler horse power.

"Assuming that the combustion conditions in the fuel bed were the same in both cases, we have 1826—1086=740 boiler horse power developed by the burning of combustible gases above the fuel bed of the non-combustion chamber boiler, which is equivalent to one boiler horse power per .42 cubic foot of firebox volume.

"It will be seen from these figures that the increase in capacity and efficiency was in almost direct proportion to the increase in firebox volume. Of course, it goes without saying that there is a limit to the firebox volume needed for approximately perfect combustion, and when this limit is exceeded the capacity developed per cubic foot of volume will begin to fall off.

"Increasing the firebox volume by the use of combustion chambers can only be accomplished by reducing the flue lengths and sacrificing flue heating surface, but it is a well-known fact that the additional firebox heating surface so gained has a much higher value per unit of area than the discarded flue heating surface, and while accurate tests are necessary to develop the absolute values of the different heating surfaces, the fact remains that boiler capacity and efficiency depend more upon efficient combustion than upon mere area and extent of heating surface.

"The over-all boiler efficiency of the combustion chamber boiler referred to above varied from 82 to 51 per cent, and the furnace efficiency ranged between 97 and 66 per cent, while the heating surface efficiency ranged from 97 to 93 per cent.

"Firebox volume is as essential in oil burning service as in bituminous coal burning, for in the former all of the heat is liberated by burning fuel in suspension.

"There are in use some 6,000 locomotives equipped with combustion chambers, of which 1425 are the U. S. Government standards and 460 are of the Gaines type. These combustion chambers range in length from 18 in. to 11 ft. and are used in conjunction with flues varying in length from 9 ft. to 25 ft. It is evident from these figures that there has been no logical method of procedure followed in proportioning combustion chamber and flue lengths, and there is room for a lot of scientific investigation to determine the correct ratios between firebox volume and grate area, and between firebox heating surface and flue heating surface. It is

also desirable to arrive at some correct understanding as to the value of firebox heating surfaces and flue heating surfaces and the arrangement and location of heating surfaces, such as will give the maximum evaporation and efficiency per unit of surface.

"Extensive tests have been carried out by the Bureau of Mines at its Pittsburgh laboratories in trying to determine the ratio of furnace volume to grate area for the different kinds of coal used in stationary service. These tests show that in order to reduce the heat loss due to unburned gases to 2 per cent, it was necessary to have the ratio of furnace volume to grate area about 13 to 1 when burning Illinois coal at a rate of combustion of 60 pounds with a 25 per cent excess of air. Under the same conditions, Pittsburgh run-of-mine coal required a surface volume of ten times of grate area, while Pocahontas low volatile coal required a volume five times the grate area. These tests are not strictly comparable to locomotive practice for the reason that in the latter much higher rates of combustion prevail, and the excess air supply is generally lower than that mentioned.

"Under these conditions it might be necessary to have a higher ratio of volume to grate area than those required in stationary service, in order to secure approximately perfect combustion of the gases.

"Future developments and improvements in the art of burning coal in the locomotive firebox will probably depend to a large extent upon the changes made in the design and proportions of the firebox itself, and it is in this direction that we must look for innovations that will successfully meet the constantly increasing demand for boiler capacity and efficiency.

"As an indication of this, we might mention that while the oil burning locomotive referred to developed 4.6 boiler horse power per cubic foot of firebox volume, and the coal burner developed 2½ boiler horse power per cubic foot of firebox volume, stationary power plants are being designed and built for burning coal in suspension with furnaces of such size that the desired boiler capacity can be developed at a rate of ½ boiler horse power per cubic foot of furnace volume.

"No mention has been made of the effect that the introduction of combustion chambers has upon boiler maintenance; but it is a well-known fact that short flues give less trouble and fewer failures than long flues, and that moving the back flue sheet forward and away from the zone of high temperatures in the firebox materially reduces trouble due to flue leaks and failures.

"Viewed from any angle, the combustion chamber firebox is apparently superior to that of the non-combustion chamber type; but there is a woeful lack of correct and authentic information concerning this most important subject, due to the fact that such knowledge can only come through a correct interpretation of experimental facts."

Railway Supply Manufacturers' Association

Closely associated as the Railway Supply Manufacturers' Association has been with the Master Car Builders and American Master Mechanics' Associations, as was to be expected no annual exhibits have been held during 1917 and 1918. The members have by no means been idle during that period. As considerable preparation had been made for the exhibit in 1917, the postponement of the conventions caused some loss to the Railway Supply Manufacturers' Association. The signing of the armistice, however, was the signal for renewed activity, and the various committees immediately set to work with the

EDMUND H. WALKER

assurance that the meetings would be resumed this year. The vast space in the various buildings on Young's Pier, Atlantic City, was not only completely taken up, but in many cases a number of exhibitors were compelled to be content with limited spaces allotted to more than one exhibitor. The officers of the mechanical department of the Railroad Administration coöperated heartily with the Railway Supply Manufacturers in their laudable efforts to make a success of this year's exhibits, and the result was even beyond the most sanguine expectations of the promoters.

The president, Edmund H. Walker, vice-president of the Standard Coupler Company, New York, presided at the meetings of the association, and was ably assisted by the other officers and committees. The executive committee, of which there are twelve members, were selected from the various geographical districts, besides which there were the exhibit committee, the entertainment committee who had charge of the entertainment features, the transportation committee, the enrollment committee who had charge of the enrollment of members for both the railway and the supply associations. There were also sub-committees on finance, by-laws and resolutions, and other details. Over 300 separate exhibits were crowded into the buildings, even the main corridors and other spaces being utilized for the display.

A special feature of the entertainment on the evening of Saturday, June 21, was in addition to a musical program, selections by the Royal Scottish Highlanders Brass Band. Speakers of national reputation addressed the members and guests. Among others being Hon. Josephus Daniels, Secretary of the Navy; Brigadier-General W. W. Atterbury, Col. Henry W. Hodge and Senator Walter E. Edge. All of the speakers paid high tributes of praise to the railway men who had gone into the service during the war.

Annual Meeting.

The Railway Supply Manufacturers' Association held its annual meeting in the Hippodrome on Young's Pier on Saturday, June 21. President Walker occupied the chair, and reported verbally on behalf of the Executive Committee, and expressed the general feeling of the members at the large and enthusiastic attendance of members and guests, among the latter being twenty members of the Executive Committee of the American Railroad Association, who had personally attended the meeting of Section III, Mechanical, on June 20.

A resolution was adopted increasing the amount of reserve funds in the treasury of the association from $5,000 to $10,000. The elections of members of the various committees followed, and in the election of officers George R. Carr, vice-president of the Dearborn Chemical Company, Chicago, Ill., was elected president, and J. F. Schurch, of the T. H. Symington Company, Chicago, was elected vice-president.

American Railroad Association.

A meeting of the Executive Committee of the American Railroad Association was held on June 19. The association has been reorganized, and the following elected officers: President, R. H. Aishton, regional director Northwestern region; first vice-president, W. T. Tyler, director of the Division of Operation; second vice-president, E. H. Coapman, federal manager Southern railroad; general secretary and treasurer, J. E. Fairbanks; assistant general secretary and treasurer, H. J. Forster.

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The Return of the Railroads.

The return of the railroads to their owners is a foregone conclusion, and it is gratifying to observe that while Congress is not disposed to furnish all the means that the Director General asks in order to place the properties in as good condition as they were before being taken over by the Government, there is every indication that in time a just and equable settlement of the intricate problem will be made. Whatever fault may be found with the management or mismanagement of the roads under Government control it must be admitted that in a great national emergency the situation was handled with a degree of efficiency that reflects the highest credit on the intelligence and capability of the Government to handle any situation or condition that may arise.

The lessons to be learned from the experience of other countries is not lost on us. It is generally accepted as true that what we need is a return to that individual effort which is a spur to more efficient and adequate service. A guarantee of earnings would be to repeat the experience of the government of France. The guaranty system in that country has resulted in a steadily increasing demand on the public treasury. Frank H. Fayant, assistant to the chairman of the Association of Railway Executives, and an excellent authority on railroad management, in a recently published statement respecting the guaranty to French railroads, clearly pointed out that the results of the French guarantee system have been disappointing. There has been no profit sharing. The Western Railway, after 44 years' continuous appeal to the state on account of its guarantee, became so hopelessly involved in the treasury finances that the state in 1908 was compelled to exercise its purchase option. Incidentally it has become a greater burden to the treasury under state operation than it was under private operation. The Southern in the half century prior to the war was able in only a dozen years to meet its interests and dividends out of earnings. The Paris-Orleans, which at one time had some hopes of becoming self-supporting, was just before the war making large appeals to the treasury. The Eastern railway was self-supporting before the war. The Northern and the Paris Lyons Mediterranean have always been prosperous, and had no need of a guarantee.

State aid in the pioneer days of railroad building in France was of great assistance in providing the capital needed for these enterprises, and in bridging the companies over the early lean years, but in later years the guarantee has only served to entangle the weaker roads in politics and public finance. It has been a handicap to progress and has stunted private initiative. The spirit of initiative is killed, and there is lowering of operating efficiency.

If we are to retain the advantages of private initiative, and save our transportation system and all our machinery of production from the deadening blight of political meddling, we ought to consider well the dangers involved in any proposal for a financial partnership between the railroads and the government. While, before the war our system of public control had its obvious faults, under it was developed the most perfect transportation machine in the world. The best railroads of Europe are many years behind ours in engineering development and operating efficiency. With this achievement before us, should we not attempt to correct the recognized faults in our system of regulation and build on the sure foundation of the past, rather than enter on an era of political experimenting with new and untried policies?

It is no idle boast to say that when the railroads are returned to their owners, and Congress appropriates the necessary monies for payment to them of the sums to which they are entitled; that is, the monies taken from the railroads by the Government, it will be found that the railroads will speedily resume their normal functions on a satisfactory and prosperous basis. It is idle to imagine that because the rates of wages have been raised to certain classes of railroad employees who were shamefully underpaid, that just and reasonable rates will not be provided for to meet the necessary expenses. It is not to be expected that wages will ever again descend to the deplorable depths of ante-war rates, so it is only reasonable to expect that with wages and the cost of material continuing at a higher rate than heretofore, higher freight rates and other charges will be made in order that the railroads shall be in a position to render adequate and efficient transportation service to meet the ever-expanding needs of our country. Naturally, the commerce of the country cannot go on expanding to any marked extent without entailing a corresponding benefit to our transportation systems which are indissolubly linked together with the commerce of the country.

Needs of a Reconstruction of the Patent Office.

It will be almost universally admitted that, apart from her material resources the United States owes her commanding position in the economic sphere more to the inventive genius of her people than to any other single factor. The development of those material resources is due mostly to the processes and mechanisms which have resulted from invention. Unaided labor, that is, primal human energy, would have been of but little avail in extracting the enormous wealth from the bowels of the earth in gathering the immense crops, in producing the stupendous output of steel and other metals in the mills and refineries, in fabricating the huge quantities of manufactured articles that came from the factory and shop, and in transporting the raw and finished materials that make up our almost unlimited tonnage of rail and shipping.

Without the influence of invention we could not conceive of the modern world as developed from the old world of manual operations. Without such inventions as the steam engine, the locomotive, the steamship, the telegraph, the telephone, the automobile, the dynamo, the motor, the reaper, the cotton gin, the printing press, the smelting furnace, our present civilization could not exist. To invention alone do we owe vastly increased production of the fruits of the earth, and of the materials of manufacture. To invention alone must we look for such further increase of wealth that the reasonable aspirations of every civilized being may be provided for.

Inventors have been and will continue to be our best benefactors. Since the establishment of the American republic our legislative bodies have endeavored to encourage them by safeguarding their rights to a reasonable share of the profits that may arise from the merit of their inventions. Hence the establishment and

maintenance of the Patent Office, an institution national in scope and character, where a body of experts examine and report upon such inventions as may be submitted to their scrutiny. Its approval automatically gives the inventor an opportunity to exploit his ideas in concrete form. A patent once secured is further safeguarded by law, to which the inventor can appeal in case of infringement. Beyond this we cannot be expected to go.

Such an institution should be self-sustaining, and so it is, but it appears that its resources, which are ample, are diverted to other purposes, and a constant clamor goes up that there is not a sufficient staff of experts to keep pace with the work, and the work of examining and reporting is delayed beyond all reason. Taking at random from the *Official Gazette* of May 20, 1919, page 449, we find Electric Regulator, filed August 13, 1914. The device is not particularly complicated, and yet nearly five years, through which the whole world has gone through many changes, has elapsed since the inventor, whoever he may be, has had his claim adjudicated upon. Surely, "there is something rotten in Denmark," and we are not surprised that a Patent Office Society has been established in Washington, the members of which are determined to effect changes in the Patent Office. It is high time. Such a state of things should not exist. It is at variance with our national character. It is a travesty on that spirit of promptness which distinguishes us as a people. The Patent Office has utterly failed to keep up with its work, and should, at any cost, be charged with the electricity of action. The Society should be encouraged in its efforts to effect its purpose.

Railroad Appropriation.

A cry has gone up because of the $1,200,000,000 asked for by the Railroad Administration. Congress has only granted $750,000,000 for the remainder of the calendar. This will not meet all the requirements for the time specified, but in view of the enormous appropriations necessary to meet the aftermath of the great war it is something to be grateful for. The United States has never repudiated any debt so far, but on the contrary has been repeatedly imposed upon, and it is not too much to prophesy that all obligations will be met, if not in due time, at least, some time, and let us exercise our souls in patience. Let us pray that all of our customers are not only as well disposed to meet their honest obligations, but as able as is our stable government that has come so triumphantly out of the threatened cataclysm of barbarism which our armies have helped to trample underfoot.

Soaking Wood.

It appears that in early British practice the seasoning of large sticks was carried on by immersing in sea-water for a period of three years, more or less, the saps and resins were dissolved and washed out, and the pores of the wood left open and filled only by water. The subsequent drying was then easily, quickly, and uniformly carried on throughout the stick, and the resultant deposit of salt acted as an antiseptic just as the creosote does in the modern process. This was perhaps the most perfect seasoning possible, or ever accomplished.

In experiments made in the last two years involving an entirely new process of drying timber an effort was made to use the same process that nature does, and dissolve, neutralize, or wash out the sap and other liquids or semi-liquids which obstruct and close the pores, and to do this within a reasonable time, much faster than nature unassisted can accomplish the work. Hot water is more effective than cold water, and hot vapor of water is, in some cases, still more so. In the new process, which is simplicity itself in theory, although the best form of mechanical application took much time and thought to study out, warm vapor, or, in other words, warm air, saturated with moisture, is circulated among the ties. The liquid components of the saps and resins, filling the vesicles themselves, expand with the heat and force their way out, to be diluted and carried away by the warm vapor. After some hours of this treatment, the amount of moisture is reduced by very slow degrees, until, at the end, it is practically dry and the timber is removed with not more than 5 per cent of moisture left in it. The rapidity with which this is done depends upon the size of the sticks and the nature of the timber, just as it does in other methods, but no subject has yet been found which did not, in the end, yield to treatment. Care is taken not to let the temperature of the kiln get above 160 deg. F., so that no injury may be done to the fiber of the wood.

It is believed that timber treated in this way is indestructible; except by fire, so long as it is kept dry; and even without further treatment it will undoubtedly long outlast unseasoned material. In this condition it is, of course, well suited to receive the creosote treatment, but instead of this expensive treatment a waterproofing coating, costing much less, is used.

The prospect which is opened up by this process is something more than merely getting the equivalent of the creosoted tie at a less cost. It is, besides, the potentiality of using for ties timbers which are now useless for the purpose, or nearly so. The northern birch, for instance, is a strong, reliable wood, used by the Indians for every purpose requiring a hard wood, but unavailable for ties or bridge timbers on account of its superabundant sap and its consequent tendency to rot rapidly. The poplar and balsam are others for which there is at present practically no demand. These timbers are particularly interesting to us just now on account of the recent opening up by the railways of thousands of square miles of northern forests, of which, with the spruce and jack-pine, these are the main constituents. The use of these woods for commercial purposes means millions of dollars to the railways in reduced cost of ties and in freight.

British Coal Output.

A statement has recently been made by a prominent member of the Government that, owing to the continued decrease in the output of coal in Great Britain, it will be necessary either to reduce the supply of coal to industry and for domestic use or to limit exports still further. The estimated reduction in output involved on the shortening of the working day by one hour at 10 per cent in a full year. This on the basis of the tabulated figures for the first quarter of this year, means a further reduction of about 10,000,000 tons in the year's output, which gives a total production for 1919 of some 214,000,000 tons. The fall since 1913 would thus be 73,000,000 tons—the exact amount curiously enough, of Great Britain's coal exports in 1913. In other words, the normal surplus available for export will have been wiped out.

Rustless Steel.

The *Scientific American*, in describing a new kind of rustless steel, states that the new metal, with a bright surface and able to resist the corroding effect of air, water and acids without staining, was discovered just prior to the outbreak of the war, and was immediately commandeered by the British Government for use in airplane construction and for purposes where strength and durability, combined with rust-resisting qualities, were invaluable.

The steel is a Sheffield invention, and was chanced upon largely by accident. A local metallurgist, Mr. Harry Brearly, author of numerous standard works, was experimenting in the armament shop to find a means of preventing erosion in gun tubes. After some of his experiments he noticed that certain pieces of chrome steel had not suffered from corrosive influences under conditions which would have rusted ordinary steel. He followed up this clue, and what is known as stainless steel was eventually worked out and added to Sheffield's metallurgical triumphs.

I am unaware of anything that has a right to be called an impossibility.—Thomas B. Huxley.

Air Brake Department

Questions and Answers

Locomotive Air Brake Inspection.

(Continued from page 179, June, 1919.)

809. Q.—Why cannot such a test be made with the cross compound compressors?

A.—Because the low pressure air piston is moving upward and compressing air at the time the high pressure piston is going downward.

810. Q.—How is the difference between packing ring and discharge valve leakage ascertained with the 9½-in. and 11-in. pumps?

A. In practically the same manner, pumping up some air pressure in the main reservoir, stopping the pump and opening the oil cock and removing the plug from the cylinder head, which will show discharge valve leakage.

811. Q.—And packing ring leakage, if the discharge valves do not leak?

A.—By replacing the cylinder head plug and noting the blow back from the oil cock when the piston is on the down stroke.

812. Q.—It has been mentioned that any of the compressors may make short strokes on account of leakage by the reversing valve seats, or valve stem packing rings. How is the disorder aggravated?

A.—By admitting an excessive amount of oil to the steam cylinders.

813. Q.—In a case of emergency, what may be done to temporarily get the compressor to making a full stroke?

A.—Removing the oil and applying a small quantity of flour of emery. This will usually produce enough friction to hold the valves in place, if this is not followed by the feeding of too much oil from the lubricator, and at the first opportunity proper repairs must be made.

814. Q.—It has also been mentioned that loose air piston packing rings cause a compressor to fail to draw in air on one stroke, how can this be temporarily overcome?

A.—By bleeding the air out of the main reservoir, and giving the air cylinders an excessive amount of oil, and making the necessary repairs at the first opportunity.

815. Q.—Should the necessary repairs be made while the compressor is on the locomotive?

A.—Under no circumstances. Compressors requiring heavy repairs should be removed from the locomotive.

816. Q.—What is generally wrong with a compressor that cannot be started after the fire has been drawn for several days, with the locomotive in the shop or storage yard?

A. It is generally very dry or the main valve packing rings have become corroded in the piston grooves.

817. Q.—Do steam and air piston packing rings ever become stuck in the grooves at such times?

A.—Yes; this is generally the time they do become corroded in the grooves.

818. Q.—Does the color of the air compressor piston rod ever signify the condition of the air cylinder?

A. It is not relied upon to indicate the condition of the compressor, but when the air cylinders are in good condition with no stuffing box leakage the rods are generally a highly polished blue.

819. Q.—What is indicated by a dull gray color of the piston rod?

A.—That the compressor has been overheated, and that if the blue color ever did exist, it has been burned out of the rod.

820. Q.—Is there anything else that will indicate that the compressor has been running hot?

A.—Yes. The color of the metal surrounding the discharge valve cavities will have the point burned off, and will be a clay color if the compressor has been running hot.

821. Q.—How are restrictions in the discharge valve passages detected?

A.—By removing the discharge valves, caps and cages, and starting the compressor, the volume of air discharged from the cylinder will indicate the extent of the stoppage if there is any.

822. Q.—How is stoppage in the receiving valve passage detected?

A.—By running the compressor with the receiving valves, cages and caps removed. The blow back from the cylinder will show the amount of restriction that exists.

823. Q.—Sometimes a compressor is found that will not maintain the required air pressure on account of a slow speed, after it has been properly overhauled?

A.—This is usually caused by a restricted steam supply, and is frequently due to cracks or flaws between the ports in the steam cylinder.

824. Q.—How do cracks between the ports develop?

A.—Usually by permitting them to freeze up in cold weather.

825. Q.—How can they be detected?

A.—By a blow from the exhaust port of the compressor.

826. Q.—What might be wrong with a compound compressor, when the low pressure air piston makes a fast down stroke and a slow up stroke, and draws in no air on the down stroke?

A.—In addition to the broken or stuck open intermediate air valve, or the loose low pressure air piston packing rings, it might be due to an upper air cylinder gasket broken between the cylinders.

827. Q.—And if the piston movement is the reverse, fast going up and slow coming down and no air is drawn in on the up stroke?

A. It is due to a broken or stuck lower intermediate air valve, or a lower air cylinder gasket broken between the cylinders.

828. Q.—Is the action of the low pressure air piston in the duplex compressors the same as in the compound in the event of broken intermediate air valves or air cylinder gaskets broken between the cylinders?

A.—Yes. The piston speed will be slow in the direction of the defective part and rapid away from it.

829. Q.—What could be wrong if the low pressure air piston speed was slow in one direction and normal in the other?

A.—It would indicate stuck shut intermediate valves or a restricted air passage at the end of the cylinder toward which the slow movement occurred.

830. Q.—How is the capacity or efficiency of a compressor affected by an increase in the main reservoir pressure it is being operated against?

A.—The capacity, or rather what is termed the volumetric efficiency, decreases in proportion to the increase in pressure.

831. Q.—How does the capacity of the cross compound compressor compare with that of the 9½-in. and 11-in. pumps when working against a constant air pressure of 130 lbs.?

A.—The air delivery of the 8½-in. is 3 1/3 times that of the 8½-in. and 2¼ times that of the 11-in., all operating with a wide open throttle and 200 lbs. steam pressure.

832. Q.—What is the duty of the pump governor?

A.—To so control a flow of steam to the compressor that a predetermined air pressure will be maintained in the main reservoir and permit the compressor to start promptly upon a depletion in pressure.

833. Q.—What air pressure is used to operate the governor?

A.—Main reservoir pressure with a single top governor, and both main reservoir and brake pipe with the SF type.

834. Q.—From the main reservoir, where does compressed air flow?

A.—To the brake and signal pipe and to any other air-operated devices.

835. Q.—For the brake equipment

alone, how many branches has the reservoir pipe?

A.—Usually five.

836. Q.—To what parts do they supply main reservoir pressure?

A.—To the brake valve direct, to the feed valve, reducing valve, air gage, pump governor, distributing valve and dead engine fixture if one is used.

837. Q.—What reservoir pipe connections are sometimes omitted?

A.—The one to the feed alve when the feed valve is attached to the H6 brake valve, the one to the dead engine fixture when this part is omitted, and the governor connection is sometimes made to the reservoir connection pipe or to the main reservoir direct.

838. Q.—How is the engine hauled dead in a train if the dead engine fixture is omitted?

A.—By leaving the brake valve cut out cock open, unscrewing the adjusting nut of the brake pipe feed valve to maintain about 10 lbs. pressure and plugging the brake valve service exhaust port.

839. Q.—Should anything be done to limit the brake cylinder pressure?

A.—The adjusting nut of the safety valve of the distributing valve should be slacked off to prevent more than 30 or 35 lbs. pressure in the applicaiton cylinder and consequently the brake cylinders.

840. Q.—What is the object?

A.—To prevent the possibility of wheel sliding when no one is riding the engine.

841. Q.—With the equipment of the dead engine arranged as stated, how is the main reservoir charged?

A.—Through the open brake valve cut out cock, and through the brake pipe feed valve in the reverse direction.

(To be continued.)

Train Handling.

(Continued from page 180, June, 1919.)

855. Q.—What should be done with hose couplings after they have been used in this manner?

A.—They should have the couplings gauged before being returned to service.

856. Q.—What can be done if the brake pipe is bursted or broken under the tender?

A.—The brake and signal hose may be connected front and rear of tender and the signal pipe used to convey brake pipe pressure from the engine to the brake pipe of the cars.

857. Q.—Can the same thing be done in the event of a broken brake pipe on a passenger car?

A.—Yes, but the car discharge valve should be closed

858 Q.—For what purpose?

A.—To prevent the possibility of anyone attempting to use the signal whistle from this car and make a brake pipe opening instead

859 Q.—How would this affect the signal whistle?

A.—It would be operative on the train ahead of the broken brake pipe, but inoperative back of it.

860. Q.—Sometimes the brake pipe branch to the triple valve is broken on a car near the triple valve; what should be done?

A.—Close the stop cock in the branch pipe and bleed the auxiliary reservoir or other air reservoirs that may be on the car.

861. Q.—Sometimes the brake pipe branch is broken off at the stop cock but on the main brake pipe side.

A.—In this case it may be possible to remove the broken piece og pipe and unscrew the cut out cock and good nipple and screw this into the main brake pipe, closing the stop cock.

862. Q.—What would be done if the supply pipe to the distributing valve was to break off?

A.—If near the distributing valve reservoir, the supply pipe cut out cock would be closed, if between the cut out cock and main reservoir pipe it would be necessary to plug the pipe to stop the main reservoir leak.

863. Q.—Would there be a driver brake under this condition?

A.—No; engine and tender brakes would be inoperative.

864. Q.—What might be done if time permitted and both ends of the broken pipe could be removed?

A.—It might be possible to make a connection with two signal hose.

865. Q.—Where could they be secured if there was none in the tank box?

A.—One from the pilot and the other from the rear end of the train.

866. Q.—Is the thread on the signal hose same as the threads in the fittings of the supply pipe?

A.—Yes, both are standard ¾-in. pipe thread.

867. Q.—Would it be possible to operate the driver brake on a lone engine if the distributing valve supply pipe was broken and no connection could be made?

A.—Yes, but both ends of the broken supply pipe must be closed.

868. Q.—How would it be done?

A.—By unscrewing the cap nuts of the quick action cylinder cap and removing the emergency slide valve and cylinder check valve and replacing the cap nuts.

869. Q.—How would the brake valve handles be carried?

A.—The automatic in service application position and the independent valve in slow applicaiton position.

870 Q.—What would be the condition of the brake pipe and application portion of the distributing valve?

A.—The brake pipe would be empty and the application portion in applicaiton position.

871. Q.—How would the brake be applied?

A.—By moving the automatic brake valve to release position.

872. Q.—And the main reservoir pressure would flow?

A.—Into the brake pipe and through the quick action portion of the distributing valve into the brake cylinders.

873. Q.—How would the brake be released?

A.—With the independent brake valve after rturning the automatic brake valve to service position.

874. Q.—And after which?

A.—The independent valve is again placed in slow application position.

875. Q.—If more than 45 lbs. pressure was admitted to the brake cylinders would there not be a waste from the distributing valve exhaust port?

A.—Yes, but if more brake cylinder pressure was required, the reducing valve could be adjusted to the amount desirable to use.

876. Q.—What if the engine was equipped with a plain cylinder cap on its distributing valve, and the supply pipe was broken off, no repairs or connections could be made and it was necessary to have a driver and tender brake for the lone engine?

A.—The equalizing cylinder cap gasket could be removed and a passageway cut betewen the brake pipe and brake cylinder port. When replaced in the proper position, the brake would be operated as previously explained.

877. Q.—Could the brake on a train be operated while such a temporary brake was arranged for the engine?

A.—No.

878. Q.—What would be done if the brake cylinder pipe was to break off at the distributing valve?

A.—There would be no brake on the engine or tender, therefore the stop cock in the distributing valve supply pipe would also be closed.

879. Q.—For what purpose?

A.—To prevent the escape of main reservoir pressure when the brake was applied on the cars of the train.

880. Q.—What if the pipe broke off while running along the road and was first known of by a loss of main reservoir pressure while making a slight reduction?

A.—The independent brake valve could be placed in release position to prevent the loss of main reservoir pressure until the supply pipe cut out cock could be closed.

881. Q.—How would this prevent the loss of main reservoir pressure?

A.—Exhausting the pressure from the application chamber would permit the application piston graduating spring and the in-rush of main reservoir pressure to move the application piston to lap position.

882. Q.—What would be done if the brake cylinder pipe under the tender was broken?

A. The stop cock in the pipe leading

to the tender brake cylinder would be closed.

883. Q.—Is this cock located on the engine or tender?

A.—On the engine.

884. Q.—What if one of the brake cylinder hose between the engine and tender was to burst?

A.—Close the same stop cock until another hose can be applied.

885. Q.—What kind of hose are these?

A.—The standard ¾-in. signal hose.

886. Q.—What would be done if the brake pipe branch to the distributing valve was to break off.

A.—The opening from the brake pipe would be plugged.

887. Q.—Where would the brake valve handle be in all cases of a broken brake pipe?

A.—On lap position.

888. For what purpose?

A.—To accumulate the maximum main reservoir pressure for a release of brakes after the pipe has been temporarily repaired.

889. Q.—In the case of the broken brake pipe to the distributing valve, how would the engine brake be released if only the brake pipe leak was plugged?

A.—With the independent brake valve.

890. Q.—Would the engine then be without a driver or tender brake?

A.—No; the independent brake could be used in conjunction with the automatic brake on the train.

891. Q.—Would the engine and tender brake apply with the train brakes if the brake valve was used in emergency position?

A.—Yes.

892. Q. In what manner?

A.—With the brake valve in emergency position, the flow of air through the blow down timing port would operate the distributing valve.

893. Q.—Why is it necessary to use the independent brake valve to release with?

A.—Because the equalizing valve is in emergency position and remains there and the pressure must be taken out of the application cylinder with the independent brake valve.

894. Q.—What would be done in the event of a broken application cylinder pipe?

A.—The opening toward the distributing valve would be plugged.

(To be continued.)

Car Brake Inspection.

(Continued from page 181, June, 1919.)

795. Q.—For what purpose?

A.—To distribute the wear on the leather.

796. Q.—Where is most of the wear on a packing leather?

A.—At the bottom of the cylinder.

797. Q.—Why?

A.—Principally on account of the weight of the piston resting on the bottom side of the leather.

798. Q.—About what percent of saving in wear can be affected by the method of turning the leather each time the cylinder is cleaned?

A.—About 100 per cent.

799. Q.—How so?

A.—As the leather first wears through at the bottom it can be expected to last just twice as long if the wear is equally distributed.

800. Q.—What care must be taken in applying the expander ring?

A.—It must be known to be in place between the packing leather and the follower plate and the opening in the ring at the ends should be at the top of the cylinder.

801. Q.—How far will the opening then be away from the leakage groove?

A.—One-quarter of a turn of the piston.

802. Q.—Why should the opening of the ring be away from the leakage groove?

A.—To prevent an effect that might be similar to an enlarged groove, that is, a greater opening than desired might result and the ends of the ring or one end of the ring might be directly in the leakage groove and tend to injure the leather.

803. Q.—What should be the maximum opening permitted at the ends of the expander ring?

A.—Three-eighths of an inch.

804. Q.—The minimum opening?

A.—One-quarter of an inch.

805. Q.—What care should be taken in the use of tools for entering the leather and piston in the cylinder?

A.—No sharp tools should be used in entering the leather and piston.

806. Q.—Why not?

A.—On account of the liability of damaging the leather.

807. Q.—Are any kind of tools whatever necessary?

A.—No, not if the leathers have been formed and an experienced man is applying the piston and leather.

808. Q.—How should the piston be handled when being entered into the cylinder?

A.—The piston will be entered at an angle, and when it is about one-fourth of the way back in the cylinder, the piston should be raised to a horizontal position at the same time the piston is pulled part way out toward the front of the cylinder.

809. Q.—Why is this?

A.—To prevent the leather from being turned in the opposite direction when being entered into the cylinder.

810. Q.—How can it be determined whether the expander ring is then in place after the piston is in position in the cylinder?

A.—By moving the end of the piston and cylinder head in a circular movement.

811. Q.—Can this be done if the expander ring is out of place?

A.—No, the piston will bind in the cylinder.

812. Q.—What difficulty is encountered in entering a piston and leather when an expander ring of the J. M. or Johns-Manville type is used?

A.—The piston will be exceedingly difficult to enter if it is to be done in the same manner that a standard ring is applied.

813. Q.—How can this type of ring be entered without any difficulty?

A.—By tying the ring in place around the follower plate with a piece of string, the outside of this ring being flat.

814. Q.—When is the string removed?

A.—After the largest part of the piston is entered in the cylinder, or rather after the sides of the leather have the ring securely in place between the follower plate and the leather.

815. Q.—How is the string then removed?

A.—By cutting it in half and pulling it out.

816. Q.—After the piston is started into the cylinder it is sometimes found that it cannot be forced in because of a cushion of compressed air forming, what causes this?

A.—The triple valve is on lap position and the slide valve is closing the brake cylinder exhaust port.

817. Q.—What must be done before the piston can then be entered?

A.—Either a plug must be removed from the high speed reducing valve to open the brake cylinder to the atmosphere or the cylinder cap nut of the triple valve and the graduating spring and stem must be removed and the triple valve piston pushed to release position.

818. Q.—After the piston is in place and the nuts of the non-pressure head are tightened, and the brake rigging connected, what is the first thing that is to be done?

A.—The brake cylinder is to be tested for leakage.

819. Q.—In what manner?

A.—By charging the reservoir, screwing an air gage into the triple valve exhaust port and by then making a full service or 25 lb. brake pipe reduction and increasing the brake pipe pressure to return the triple valve to release position.

820. Q.—How will the rate of brake cylinder leakage then be shown?

A.—In pounds per minute by the fall of pressure shown by the air gage.

821. Q.—What is the maximum allowable leakage from a cleaned or repaired brake cylinder and its connections?

A.—Five pounds per minute.

822. Q.—Where might leakage occur in addition to that escaping past the packing leather?

A.—From the brake cylinder gasket, the seat of the high speed reducing valve piston, from the reducing valve pipe connection, or from the safety valve if the L triple valve or universal valve is used.

823. Q.—What would cause packing leather leakage, in a good cylinder with properly fitted follower studs, and a leather in apparently good condition?

A.—A porous leather.

824. Q.—How should a suspected leather be tested?

A.—It should be tested in a perfect cylinder kept in the shops for this purpose.

825. Q.—Where may brake cylinder leakage in a high speed reducing valve be found?

A.—Past the piston washer, as mentioned, from the pipe connection, past the slide valve seat or from the threads of the cap nut.

826. Q.—At what point does the leakage past the leather washer escape?

A.—Through the port through the check nut which is attached to the bottom of the reducing valve.

827. Q.—What attention should be given this valve?

A.—It should be cleaned and tested, and adjusted, if necessary, every time the brake cylinder is cleaned.

828. Q.—What attention should be given the safety valve of the L triple valve or the universal valve?

A.—It must be cleaned and tested every time the triple valve or universal valve receives attention.

829. Q.—What is a good practice to follow to prevent brake cylinder lubricant from working into the operating valves and into the pressure regulating devices?

A.—To remove the brake cylinder piston a second time when cleaning a cylinder, for the purpose of removing any surplus lubricant that may have accumulated in the back of the cylinder when the piston was replaced.

830. Q.—What is it well to observe in connection with the opening of an expander ring when it is out of the cylinder or free?

A.—That the ends are from 1½ in. to 1 9-16 in. apart.

831. Q.—When necessary to renew a brake cylinder gasket, how is it held in place on the cylinder head?

A.—After the seat for the gasket and the flange of the cylinder are thoroughly cleaned, the gasket should be stuck on the cylinder head with a good grade of glue.

832. Q.—Why use glue?

A.—It will prevent the gasket from being blown out.

833. Q.—How should the glue be applied?

A.—In a very small quantity on the cylinder head, merely enough to cover the surface the gasket rests on.

834. Q.—What advantage will be obtained by this method of applying gaskets?

A.—The life of the gasket will be prolonged, and when the cylinder head is thereafter removed, it may not be necessary to renew the gasket.

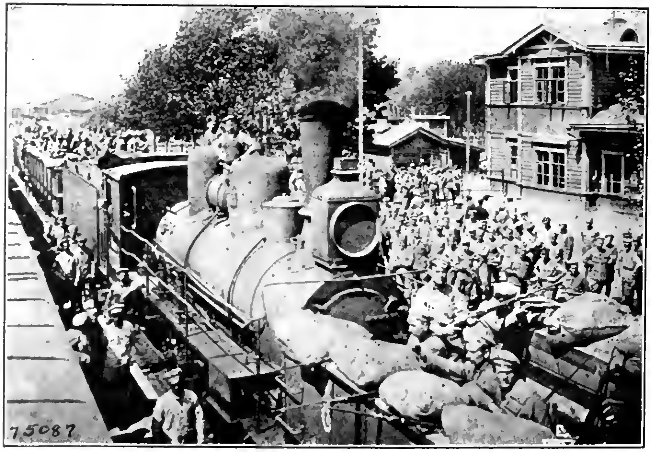
(To be continued)

Train in Czecho-Slovakia Protected by Sand Bags

While the peace conference has been working overtime in a heroic effort to remodel the map of Europe, the Czecho-Slovaks and the Hungarians have been at each other throats disputing about the new boundary lines. The Bolshevikis and the Reds have been taking a hand. There were two monkeys one time that quarrelled about the division of a piece of cheese, and they called on the fox to settle the dispute. The fox set to work with a pair of scales, and began biting off portions of the divided piece of cheese in order to get them exactly balanced. At last the monkeys tumbled to the situation and were glad to get something. If the disputed territory had been contiguous to France, Clemenceau would have been a fine fox, but the territory is too far removed from the sunny valleys of France.

As it is, the Czechs are showing themselves ready and willing to hold their own with a degree of valor worthy of their alleged ancestors, who, dim as Ossian's ghosts, may be rejoicing in the stars, to see that their descendants know how to protect themselves. Our illustration shows that they know how to protect themselves with sandbags, and if they can sandbag the enemy as effectually the golden wings of peace may cast its white shadow over them in the near future.

It will be noted that the locomotive is not quite in accordance with the regulations of the United States Railroad Administration, but it may do in a push. Shakespeare says that "men rather do their broken weapons use than their bare hands," and while the equipment rather seems to belong to the last century than the present, the Czechs are evidently determined to use what they have rather than wait for Mr. Hoover's new appliances. One blast of a quadruple-cylindered Mallet equipped with a superheater, would be worth ten thousand men to the heroic Czechs, but it is to be hoped that they will be able to make it hot enough for their enemies with such limited forces as they have. Meanwhile, we are informed that General Pelle of the French Army has been appointed to supreme command of the Czecho-Slovak fighting forces by President Mazaryk, and we predict that from among the Czechs themselves will arise soldiers whose names will lack nothing but pronunciation.



International Film Service.

CZECHO-SLOVAK TRAIN, SHOWING FREIGHT CARS FORTIFIED WITH SAND BAGS.

Sheet Metal Welding in Railroad Shops

By J. F. Springer

The introduction of the all steel passenger coach, coal car, etc., that has come to pass in recent years makes it necessary for the railroad repair department to handle a wider class of metal work. Take the steel coach for example. A large part of it consists of thin plates of rolled steel, particularly the roof, sides, ceiling, etc. Then other rolling stock is constructed to a greater or less extent of steel plate of various thicknesses.

In some cases, the joints will be gas welded when the car is put into service. In others, gas welding is indicated as the best mode of repair. But there are probably any number of other applications of steel and other plate in railroad property where gas welding has its uses. Water tanks, fixed coal bunkers, side walls of buildings and numerous small uses round out the railroad's interest in plate metal. Among the small items are pipes and tubes, both on and off the rolling stock. Wherever plate metal is employed, gas welding is, in general, to be considered a possible means for making and sealing the joints at the time of original construction and also, later on, when repairs are needed.

Some joints are gas welded in order to make the two parts concerned a single unit. The strength of the weld will be the strength of the finished joint. There are other seams, however, where rivets or their equivalent are employed to give whatever strength is desired at the line of junction, and gas welding is depended upon to seal the joint against leakage.

In illustration of the use of gas welding for sealing purposes may be cited a steel-coach roof-joint of the type made by riveting two plates, edge to edge, on the double flange of a T-bar. Under these circumstances, the T-bar is to be regarded as part of the framework of the roof. Even if the roof plate were a single long strip, it would need riveting to the T-bars in order to unite the roof sheet and its frame. Whether anyone is uniting the one to the other by gas or any other kind of welding, I do not know. Riveting seems the thing. But, after the riveting is done, the joints are more or less open and unfit to exclude water. Here is where gas welding comes in. It was here, in fact, that the new process was used in the early days both of the steel car and of the modern gas torch. When the sheets are in place, the welder may have only to go over the seams, one by one, where edge abuts against edge, and fill in the crevice and unite the two edges into a single piece of metal.

This is not difficult. At the same time, there are points to bear in mind. If the edges are very even, and if in addition they are fitted together to make a tight butt joint, the welder may not even need to use welding rod. In such case, he heats *both* edges and causes them to flow into each other. If the small white flame is not too narrow, it may be sufficient to advance it along a straight line. Or, the situation may be such that a movement of the flame from side to side will answer better. The torch is managed so as to have the tip move round and round in a small circle and advance at the same time This enables a wider path to be heated. But, it may very well happen that the edges are more or less irregular, so that there is really a crevice between them.

THE MILBURN CUT-WELD TORCH WELDING BLOW-HOLES IN HEAVY IRON RETORTS AT EDGEWOOD ARSENAL, THE LARGEST GAS PLANT IN THE WORLD.

Indeed, it will be well to assume this as generally the case. Welding rod may be used to fill the crack. The two edges are both to be melted and metal from rod melted in between, the idea being to make the new melted metal come into contact only with melted metal. The torch may be advanced in a straight line or routed as it is advanced, circumstances ruling the matter.

It may be necessary to use a larger tip than would be necessary if the joint did not have the T-bar underneath. The bar sucks away heat from the joint. The torch must put in enough to cover this loss and still do the work required. Instead of using a big tip and wasting expensive acetylene and oxygen, another procedure will sometimes be possible. That is, the T-bar itself may be heated by means of some cheaper fuel, the application being from beneath. Of course, there are cases where a supporting piece, such as the T-bar here, can not be conveniently heated in this way.

It is well to understand the principle involved in the saving of torch gases by the method just described. When two similar pieces of the same kind of material are placed in contact the hotter one gives up heat to the cooler. If both are at the same temperature, nothing happens. Further, in the former case, the greater the difference in temperature the greater will be the flow of heat from the hotter to the cooler. Accordingly, when the T-bar is itself cold, there will be an excessive withd[illegible] b[illegible] when it is heated up, [illegible] the flow of heat into it wi[illegible] re[illegible]d.

Similarly, if [illegible] enough work to do to make it pay for the trouble, the loss of heat by conduction and radiation may be greatly diminished by heating the seam progressively in advance of the little white heating flame. It doesn't matter whence this extra heat comes, it will reduce the work of the torch in two ways—(1) by lessening the conduction away from the point of welding, and (2) by shortening the range of temperature through which the work itself, at the welding point, will have to be raised to get it to the right heat. Perhaps both of these matters need a word of explanation. The first thing depends upon the same principle as that which makes it wise to pre-heat a T-bar or other support. If the metal to both sides of the welding point and just ahead is already at a red heat, say, when the white flame comes along, then there will be a reduced loss, because these regions will be less voracious absorbers of the heat from the white flame. As to the second thing, it is perhaps sufficient to point out that if the pre-heating has already heated the welding point to, say, a red heat, the work which the white flame will have to do will obviously be much less than if the welding point were at shop temperature.

The practical question is, How shall the pre-heating be done continuously just ahead of the advancing torch? Fortunately, there is an excellent answer. There is, enveloping the little white flame and extending far beyond it, a large flame where hydrogen and carbon monoxide are understood to be undergoing combustion—the one to water vapor, the other to carbon dioxide. But, if you don't get the chemistry, never mind. The big flame is there, whether you understand it

or not. And it is a good hot flame, too, though not nearly so hot as the spot at the tip of the white flame. We get this big flame as a present. It costs us nothing. Now, this flame may often be so managed as to pre-heat the seam just ahead of the white flame. When this can be done in such way as not to interfere with the welding operation, a big gain is made. And all this is applicable and useful, whether there is a T-bar or other support underneath the seam or not. The remaining thing is, How shall the big flame be controlled so as to compel it to perform the valuable pre-heating service?

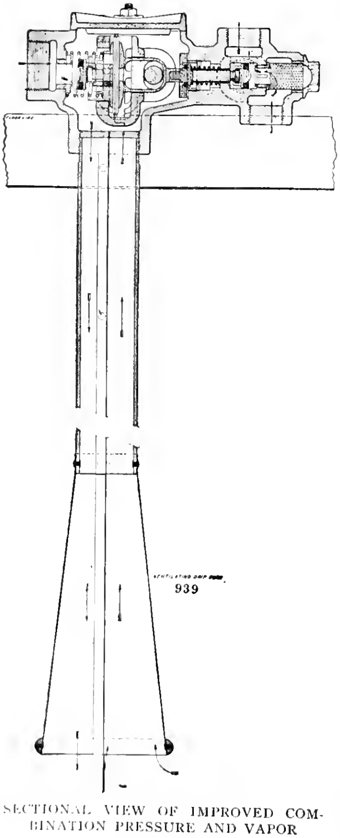
First, let me take a case from actual practice, though I can not say whether the purpose was, by pre-heating, or to save gas, preserve the appearance of the work by the protection of the big flame, or precisely what. At the same time, we don't need to know why they did it. All we need to know is how. The edges of the metal plates were held in position for welding by means of clamps whose portions on the top side of the work provided a steep valley with the joint, like a brook, at the bottom. When the white flame was directed at an angle of, say, 45 degrees, at the joint, the sides of the valley had the effect of dividing the big enveloping flame into two streamers, both of which lay flat on the seam. One streamer lay on the unwelded portion ahead; the other, on the newly-welded seam behind. It is the former streamer with which we are now interested. Here is a case where the big flame, or part of it, lies on the seam ahead of the white flame and continually lies there as the work goes on. Cheap and admirable. Why shouldn't we take the hint from this case? Why shouldn't we provide either clamps or something similar, one to each side of the seam? We may not need these things to hold the work in place—only to guide the flame.

Returns of Government Control in Great Britain.

A statement showing the cost of running the British railways during the period of Government control, 1914-1918, as presented to Parliament recently, disclosed a balance of revenue for the part-year 1914 (August 5 to December 31), of $78,521,000; for 1915, $220,598,000; for 1916, $243,880,000; for 1917, $269,609,000, and for 1918, $225,115,000; but, it is explained, "the balance of railway revenue earned over expenditure is not the amount which has been credited to the railway companies. The amount to which they are entitled is based on the net receipts of the companies in the year 1913, with certain additions in respect of capital expenditure brought into use since that time."

Gold's Improved Combination Pressure and Vapor Valve

Constant improvements are being made by the Gold Car Heating & Lighting Company on their clever devices, among the latest being a combination pressure and vapor valve, known as No. 1170. It is so constructed that by the operation of the lever handle either steam pressure or vapor is obtained in the system. It is of



SECTIONAL VIEW OF IMPROVED COMBINATION PRESSURE AND VAPOR VALVE.

packless design and non-adjustable, which is of decided advantage. As shown in the sectional view in the accompanying illustrations, the diaphragm is located in a cradle, the cradle being moved forward by a cam when the handle is set for vapor. In this position the expansion of the diaphragm is forward and the valve operates as a vapor valve. On the contrary, when the handle is set for steam pressure the cradle containing the diaphragm is moved backward, the expansion being to the rear, hence the vapor operating mechanism is held stationary in the open position, and the valve operates as a steam trap.

The construction is simple, being identical to that of Gold's vapor valve No. 1112, and No. 1165 steam trap, and is two separate and distinct diaphragms joined together as a unit, each section separately containing a volatile liquid. This increases the flexibility and power of the diaphragm and doubles its life. In the event of one section failing, the other will operate the valve until replacement can be made, thus avoiding the shutting off of steam from that side of the car. The disc holders on the vapor valve and trap are of the quick removable type, the rear portions being slipped off their respective spindles and readily replaced. The two plays on either side of the vapor chamber, giving access to one, and the cover of the diaphragm giving access to the other.

It will thus be seen that advantages are obtained without additional radiation, and the steam pressure system is available for the severest climatic conditions. Either vapor or steam pressure can be used entirely, or pressure can be used on the cold windy side and vapor on the other side of the car. Or, on the other hand, steam pressure can be used in heating cold cars at terminals in a short time, after which vapor may be used. The improved combination device can be readily applied to old equipment, the cost of equipment being very materially reduced. The weight of the equipment is one-third to one-half less than that of the ordinary vapor system, depending on the class of car. This combination valve is placed inside the car. Hence the danger of freezing is reduced to a minimum, and, not only so, but at the outlet there is less blow of steam, thereby effecting considerable fuel economy.

Specialized Machines.

It is remarkable to contemplate the splendid way in which general purpose machine tools were adapted for specialized war work. Much money and time was saved thereby, and it has given rise to serious doubts as to how far it is advisable to go in entirely for specialized equipment. Will it be possible to convert specialized machines as easily and effectively to different kinds of work as it proved with the general purpose machines? It is an important point. Probably wisdom will be found in a compromise—the use of the older type for many works and of new designs for particular factories or workshops.

If you have knowledge, let others light their candles by it.—THOMAS FULLER.

Electrical Department

Dipping and Baking of Railway Motor Armatures

All types of electric motors and generators are subject to failure, but those exposed to dirt and moisture will fail more quickly and often than those which always operate in a clean and dry atmosphere. In general the electric motor armature consists of a core, made up of iron laminations, provided with slots, in which are placed the armature coils. The coils are made up of several wires which are insulated from each other and the whole group is bound together by wrapping insulating material around them. The insulating material is generally cloth or linen which has been treated in insulating varnishes. The copper wires carry the current and the core is ground, so that the insulation around the wires and group of wires, keeps the current within. The thickness of insulation depends on the voltage of the wires. All insulating varnishes deteriorate, and much faster if exposed to dirt, etc. After the motor has operated many months, the insulation becomes "dried out" so to speak, and the pores must be filled up. A great deal can be accomplished by pointing the outside of the coils with an air drying, insulating point, but this point only serves as a surface insulation and does not penetrate into the coils any great distance.

When the insulation has become "dried out" it is "spongy" so to speak and if exposed to water or moisture a large amount will be absorbed. Water will easily work in and around the coils, getting down underneath in pockets. We all know that water and moisture is very bad for electrical apparatus and must be eliminated if possible.

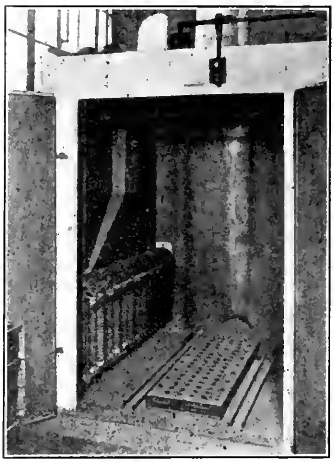
It is not always easy to eliminate the water, so that the next best thing is to protect the armature coils as far as possible, so that the water will not be able to penetrate the insulation or work down into pockets and stay, causing within perhaps a few hours or minutes a serious short circuit and a grounded motor.

The best way to protect against moisture is to dip the whole armature in an insulating varnish and then bake in a hot oven for many hours until the varnish is dry. The following description of this process refers to railway motor armatures but applies equally well to all kinds of electric motors.

The dipping and baking treatment, when properly done, provides the best method for preventing insulation troubles caused by dirt and moisture while in service. It is very important that the treatment be properly done otherwise it is worse than none.

Dipping and baking of comparatively new motors is an insurance against maintenance charges for rewinding, etc., and applying the treatment after the motors have been in service will give renewed life to the insulation. It will close up cracks and pores, and will present a smooth, clean surface that is not readily harmed by dirt and water.

The advantages of dipping and baking are: 1. The coils or windings are held in the slot securely and therefore, are less subject to individual vibration.



BAKING OVEN. HEATERS ON SIDE WALLS. VENTILATION AT SIDES AND ON FLOOR.

2. All cracks are filled up and moisture can not get into pockets, etc.

3. Loose laminations are sealed and the whole core is held tight preventing vibration.

4. The iron punchings, etc., are covered with a coating so that it serves as a rust preventive.

5. The various creepage surfaces are covered with a smooth hard layer of varnish which can be easily cleaned off by wiping, resulting in better operation.

6. The insulation of any coil which has been bruised in handling, is restored to good condition.

The equipment required for dipping and baking need not be expensive. A good oven may be constructed of two-inch asbestos block supported outside and inside by 1/16-inch sheet steel. An oven 6 feet high, 3.5 feet wide and 4.5 feet deep makes a convenient size. The door should be air tight. The heating units may consist of steam coils which should be arranged on the floor. Twenty-five standard 1.5-inch pipes the length of the oven will be about right if low pressure steam is available.

The best method, however, is to obtain the heat for baking by electricity. The amount of electric current, and hence the temperature inside the oven, can be exactly maintained at any desired value, by regulating devices.

The electrically heated oven has all of the advantages namely economy of operation; reliability of service; increased production; ease of operation and safety.

In an oven of the above dimensions, it will require 6, three-kw. heating units to heat up the oven with load, up to a temperature of 100 deg. C. in approximately two hours. After the baking temperature is reached, a smaller amount of heat is required to maintain the temperature. The resistance in heating coils are therefore divided up into a large number of units, and cut-out switches are provided, so that units can be cut out or cut in as desired.

The oven must always be ventilated, so that gases from the varnish, etc., may escape. If no ventilation is provided the air becomes saturated with moisture and the desired drying does not take place. For the above size oven, the air inlet should be at least of six 2-inch holes equally spaced, three in front and three in the rear, at the bottom. The air outlet should preferably be in the center at the top and of good size, say 6 or 8 inches in diameter, provided with a damper for regulation.

The control of electric current to the electric heaters consists, in the Westinghouse oven, of a standard magnet switch with protecting fuses. When automatic temperature control is desired, a thermostat is used. When the heat reaches a certain value the thermostat will cause the magnetic switch to open; after the oven has cooled down slightly, the thermostat will cause the switch to close. The temperature within the oven may be held constant within narrow limits, continuously and entirely automatic.

In addition to the oven for baking, a tank is required to hold the dipping and baking compounds, and some means of handling the apparatus is required.

The procedure to follow in the dipping and baking is as follows: All oil and dirt should be removed thoroughly with clean dry compressed air. If oil is excessive remove by wiping with a cloth and benzine. Motor and generator arma-

tures have polished surfaces, such as shafts and commutator and these can be protected from the varnish by wrapping with friction tape.

The piece of electrical apparatus to be treated should first be heated for approximately six to eight hours in the oven in order to drive off all moisture, and to open up the pores in the insulation. This heating should continue until the piece of apparatus has reached a temperature of 100 deg. Cent. It should then be removed from the oven and taken to the dipping tank and dipped after the temperature has dropped to about 50 deg. If dipped at a temperature much above this, the benzine which is required to dilute the compounds, will evaporate very quickly on account of its low boiling point compared to water. It is preferable to dip the armature vertically, although very satisfactory results can be obtained by rotating the armature at intervals in a shallow pan with the varnish deep enough to completely immerse to the bottom of the slot.

The armatures should drain in a vertical position, at room temperature until all dripping ceases. This draining is important because if not properly done, unbalancing may occur.

After the armature has thoroughly drained, place in the oven and bake at a temperature of 125° Cent. for several hours until all varnish is thoroughly dry. This is very important. From 24 to 48 hours may be required depending on the diameter of the armature. For armatures below 12 inches in diameter approximately 24 hours is required and armatures over 30 inches in diameter may require 48 hours of baking.

While the baking can be hurried by increasing the temperature in the oven, it must be understood that 130° C. must not be exceeded, otherwise the insulation will be damaged. The baking period must not be rushed, otherwise the varnish will be left wet and this condition is worse than no treatment. For a general application, a longer baking period at a lower temperature is to be recommended.

To sum up the following is an analysis of the above:

1. Place heating elements at the bottom of the oven.

2. If steam is used provide against any possible leak in the oven.

3. Arrange heating pipes so that the condensation will drain away.

4. Provide for the ventilation of the oven.

5. Provide a thermometer or thermostat so temperature will be known.

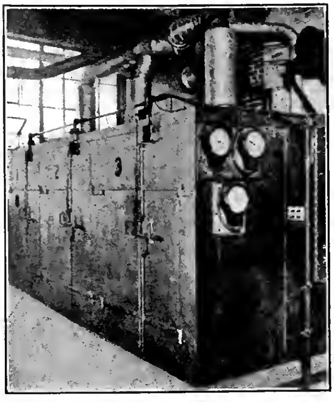
6. Avoid having tanks near sparks or fire.

7. Provide for drainage; a rack directly above the tank and draining into it is very satisfactory.

8. Improper treatment is worse than no treatment.

9. Cleanliness is necessary. Remove oil and dirt.

10. Dip until thoroughly saturated.



OVEN SHOWING VENTILATION AT TOP THERMOSTAT. RECORDING METERS SHOWN AT SIDE.

11. Bake until dry.

12. Do not exceed 130° C.

13 Do not interrupt the baking period.

Proposed Tunnel in Japan.

The Government railways in Japan have decided to cut a submarine tunnel under the Shimonoseki Strait, according to the chief of the construction bureau. It will be started this year and it is planned to complete it in 1928. At present the railway systems in Honshu and Kyushu are connected by ferryboats, but when the tunnel is completed the connection of the two systems will be much improved. The expense will be about $9,000,000 the first two years will be spent in studying the geological formation of the sea bed in the strait, drafting the general plan of work in preparation for the actual undertaking of tunneling. Experts and workmen engaged in the undertaking will be dispatched to Europe and America, where they will personally study what has been achieved over there.

In 1921 the actual work is to be begun. The official states that much depends on the geological formation of the sea bed, which is not so simple and well known as is that of the English Channel. Therefore, no definite plan of work can be established as yet. It has, however, already been planned that the tunnel line is to start for back of the Shimonoseki station. On the Moji side, also, the tunnel line will be connected with the Kyushu line at Dairi or its vicinity. This renders the level of the line low. The whole length of the line will be 7 miles, of which 1 mile will be completely under the sea.

According to this official, the completion of the tunnel will make it possible to start a through service between Tokyo and Kagoshima, and the transportation system of the country will be materially improved.

The Channel Tunnel.

The British Government has withdrawn opposition to the construction of the long proposed railway tunnel beneath the Straits of Dover. The proposals are that two parallel tubes are to be constructed, as in the case of the great Simplon Tunnel ($12\frac{1}{2}$ miles in length) under the Alps. The work of excavation will be performed by revolving cutters, fixed in Greathead Shields, and all the work will be carried on by electrically-driven machinery. The diameter of each tunnel will be 18 feet, to accommodate any of the great European express trains. It is intended that the tunnel shall be worked, ventilated and pumped by electricity. No combustion of coal on the railway will be necessary. It is suggested that the tunnel shall be maintained under the authority of the War Office and the plans include a dip in the level of the rails forming a "water lock," by which the tunnel could, in the case of emergency, be filled with water for a length of a mile.

It is interesting to note that the geological formation through which the tunnel will pass shows evidence that at one time an isthmus existed which had been cut through by a river from the North Sea, forming the English Channel.

Increase in Railroad Employees.

Walker D. Hines, Director General of Railroads, in an address delivered before the Philadelphia Chamber of Commerce on June 20, 1919, stated that in view of the fact that comments had been made upon the statistics showing that there were about 140,000 more railroad employees in January, 1919, than in December, 1917, the comments being in the nature of insinuations that there had been a laxity of supervision on the part of the railroad officials throughout the country as compared with the supervision which would characterize the operations under private control. The critics had evidently overlooked the fact that the employees were now working under an eight-hour day basis instead of ten hours as formerly. Overtime under any condition is undesirable and hence the proper policy is to obtain enough employees to avoid working overtime except in emergencies. The number of hours worked and not the number of employees working should be considered in any fair estimate. The increase in the number of employees simply illustrates the carrying out of the Government's policy that employees ought not to be required normally to work more than eight hours per day.

In January, 1919, also an exceptional amount of maintenance of roadway and structures was performed, the expenditures being 245 per cent of the expenditure for the same purpose in December, 1917.

Reclaiming Oil from Metal Turnings

A Cincinnati machine manufacturing company has developed a system of collecting steel turnings and recovering the oil that usually clings to them, with the result that a considerable saving is effected. In a shop where large amounts of turnings are produced it is difficult to collect them without wasting a considerable quantity of the cutting oil that clings to them with the attendant difficulty of keeping the shop clean. The nature of this class of scrap also makes it extremely hard to handle it economically, and this is practically impossible with the usual methods of making collections from the machines in wheel-barrows or in cylindrical cans moved on shop trucks.

In developing the system in this plant one of the first steps taken was to provide receiving trucks for conveying the turnings to the oil and scrap building located about 100 feet distant from the main plant. These trucks were designed and built in the company's shop, and the idea in their design was to eliminate the handling of the turnings as much as possible. Only two of these receiving trucks are needed and they are operated by one man.

The trucks are lined with sheet metal, and the sheet covering the sloping bottom is perforated at the lower end to allow the oil drained from the turnings to pass into the tank located below. A 4-inch baffle plate is provided at the front end to divert the oil into the receiving tank underneath and at the top of the perforated section an oil splash guard is placed for the same purpose. The oil tank has a sheet metal sliding top and can be emptied and cleaned with a minimum amount of trouble. A sliding door at the front of the truck is provided for unloading the chips that are raked into the separator. The top of the separator is level with the floor, which is more convenient and economical than if the turnings were unloaded into a separator located above floor level.

In collecting the chips from the different screw machines in the plant a specially shaped galvanized steel pan is used. This pan is placed on a small shop truck directly beneath a sliding door in the oil pan of the screw machines and the chips can be raked into it without spilling oil on the floor. The usual method of removing the turnings from the machine oil pans with a fork and putting them in a wheel-barrow or other receptacle, it is stated, requires considerably more time and a great deal of oil is necessarily dropped on the shop floor.

The collecting pans on the shop trucks after being filled are carried to the rear of the shop, where the receiving truck is stationed. These pans are provided with a trunnion at each end and the pan is raised and its contents dumped into the receiving truck by one workman using an electric hoist. This method of collecting turnings has enabled one man to take care of the entire plant, working only on the day shift. Formerly it required two men on both the day and night shifts. The amount of labor saved is obvious, and attention need not be called to the cleaner condition of the shop that has been brought about by the present system.

The oil reclaiming and scrap storage department is housed in a three-story brick and concrete building, 28 x 90 feet, that is separated from the main shop. All scrap such as borings and turnings is conveyed to the third floor on an electric elevator. The turnings are delivered to an oil separator, which has a basket of 14 cubic feet capacity. This revolving basket is lifted from its seat by a travelling hoist through two slings supporting the two trunnions attached to the basket near its center of gravity. The operator of the truck can with ease dump the dry chips in the bin where wanted.

The arrangement of the concrete storage bins for turnings to be loaded on cars is out of the ordinary. The bins have sloping bottoms and sheet metal doors that are full height of the bins, which are located on the side of the building where the loading track is placed. It will be noted that the bins are about 25 feet apart, so that a standard 40-foot car can be loaded from both ends at the same time when desired. A travelling platform operating on a runway outside the building serves the different loading ports or openings.

Cast borings are also loaded in the same way, but the loading ports are not necessarily as large as for the turnings. The same arrangement for loading at both ends of the car is provided for borings and in this instance it is necessary, as the railroad regulations require such heavy, dense material to be placed over the trucks of the car and not in the center.

On the second floor of the oil house there is a filter directly beneath the oil separator. This filter has a tank of sufficient capacity to take care of the filtered oil until it is drawn into portable tanks for redistribution to different parts of the shop. On the third floor of the oil house a small separator is provided for taking care of brass and aluminum turnings.

The records of the company show that the oil reclaimed from the turnings represent a saving during April of 3,092 gallons. During May, 2,400 gallons were recovered, the general average being about 100 gallons each working day.

Heated Bearings.

In spite of the admirable improvements in material and qualities and methods of lubrication, as the increase in atmospheric temperature occurs during July and August, the tendency of the bearings of a locomotive to become heated increases. In addition to the greater heat of the atmosphere there is also a marked increase in the amount of dust incident to all vehicular traffic in dry, warm weather. The hard particles of sand and other substances of an abrasive kind that rise with the dust, are apt to get in between the rubbing surfaces of the bearings. This may cause cutting of the bearing and may be impossible to discover without removing the bearing. Whatever the cause of the heating of the bearing may be, a liberal supply of a suitable lubricant should be applied, and if water pipes are attached, those leading to the heated box or bearing should be opened and a stream of water poured upon the heated parts.

If the heating should be in the driving box and the heating continues, it should be examined to note if [illegible] wedge is jamming the driving box. The slight expansion of the box and wedges, owing to the increased degree of temperature may be sufficient to bind the box in the wedge, in which case the wedge should be slightly loosened, care being taken not to loosen the wedge too much, which may lead the way to frame breakages and other troubles, and also it should be kept in mind to set the wedge up again in its proper place when the box has sufficiently cooled. The recent important improvement that distinguishes the self-adjusting wedge introduced by the Franklin Railway Supply Company has overcome this difficulty and while nearly all of the modern high-powered locomotives are equipped with this saving device, many of the older locomotives are not so equipped, and if liberal lubrication and cold water and wedge-loosening does not have a permanent cooling effect on the box, a remedy may be found in relieving the bearing of some of the load resting upon the box. Hard wood wedges should be carried on the locomotives, suitably formed, so as to be readily driven into the space between the frame and spring saddle, a slight raising of the saddle will considerably diminish the weight on the bearing, and reduce the tendency to overheating.

In case of the overheating of the rod brasses the matter may be more readily handled, but there is an added trouble in the readiness with which babbitt metal will melt in the brasses before any evidences of heating may have come to the notice of the locomotive engineer. Under such conditions it is generally advisable to keep the engine running until the babbitt is all melted out. Any attempt at cooling while the babbitt is in the melted state rarely fails to close up the oil holes, and adds to the amount of work to be done and increases the unavoidable delay in transportation. A loosening of the rod key, and liberal lubrication, not forgetting an appli-

cation of graphite, with added water cooling, almost always has the desired effect.

In regard to the heating of eccentric straps on locomotives equipped with the Stephenson valve gear it should be remembered not to suddenly cool a heated cast iron eccentric strap with water. The tendency to crack the strap is very great. The best method is to slacken the bolts joining the two halves of the eccentrics together and insert one or more thin liners. Lubricate well and do not move the reverse lever until the eccentric strap is fairly cooled.

American Society for Testing Materials.

The twenty-second annual meeting of the American Society for Testing Materials was held at Atlantic City, N. J., June 24-27, inclusive. President G. H. Clamer presided. Reports of committees embraced a special report on Steel, Non-Ferrous Metals and Alloys, Malleable Castings, Cements for producing Quick-Hardening Concrete was the subject of a special paper by P. H. Rates. Deep Etchings of Rails and Forgings was the subject of a specially interesting paper by F. M Waring and K. E. Hoffmann. Proportioning Pit Run Gravel for Concrete was treated by R. W. Crum. Dr. P. H. Dudley read a paper on Magnetic Surveys on New and Failed Rails, and Theoretical Studies of the Surface Method of Proportioning as Applied to Concrete was discussed by R. B. Young.

The election of officers resulted as follows: President, J. A. Capp; vice-president, C. D. Young; members of the executive committee, Ernest Ashton, H. F. Moore, and Admiral D. N. Taylor.

Coal Shortage Threatened.

The Coal Association has issued a warning that unless production can be increased immediately we shall have a coal famine next winter. According to Government figures the shortage threatens to be about 25 per cent.; more serious as to domestic suppl'es than as to bituminous and industrial needs. As to the latter, however, Mr. F. S. Peabody, chairman of the association's special committee, says:

The information gathered by the committee is that at the present rate of production one industrial plant out of every eight in the United States will have to shut down next winter for lack of coal.

It will be worse in some localities than in others, and we are warned that New York city is especially elected for trouble The only remedy suggested is a stimulation of demand and an attempt to store as much as possible in advance of the present need Easier said than done in most cases, but for all who have the storage room and the cash, or credit, with which to buy, now is a good time to stock up.

Reduction in the Number of Women Employed on Railroads.

The Railroad Administration reports show that there were 101,785 female employes in railway service in September, 1918. In April, 1919, there was a reduction of 14.3 per cent., or a total of 85,393. This was partly due to the general reduction of labor force, and also to the return of the soldiers from army service. The largest percentage of decrease from the female workers was from among the clerical force. In the mechanical section the largest number of reduction among the female employes took place in the round houses and shops. Their work in these departments was in many cases found to be unsatisfactory, the work being generally considered too heavy. In the clerical occupations more particularly fitted for women, the number employed last month amounted to 68,129, being a reduction of 11.2 per cent.

Locomotives for Mexico.

The president of the Mexican Republic has authorized the director general of national railways to complete arrangements with an American railroad company for the loan of 50 locomotives for service within Mexico. It is stated that some time ago the government received an offer from the American company for the rental of engines instead of their sale. This plan was favorably considered on account of its economy, meaning as it does, a considerable saving in immediate outlay. Orders have been sent to the purchasing agent of the Mexican railways in New York instructing him to sign the contracts in question. In view of the great need at present of engines, it is hoped that within a month after the completion of these arrangements the locomotives will be on hand. The statement is forwarded by the American consul general in Mexico City.

Locomotive Firemen and Enginemen.

The annual convention of the Brotherhood of Locomotive Firemen and Enginemen was held at Denver, Colo., last month. In addition to the general routine business and reports of special committees, addresses were made by Director-General Walker D. Hines, Warren S. Stone, president of the Brotherhood of Locomotive Engineers, and I. F. McNamee, editor of the *Firemen's Magazine*. An appropriation was made sustaining the members of the Commercial Telegraphers' Union of America during the recent strike.

Blacksmiths' Association.

The annual convention of the International Railroad Master Blacksmiths' Association, will be held in Chicago, Ill., on August 19, 20 and 21, 1919. It is recommended by the United States Railroad Administration that master blacksmiths or foreman blacksmiths, who are affiliated with the association, be permitted to attend, as far as possible, without detriment to the service. The railroads are expected to follow the usual practice in regard to reduced rates of transportation. A large attendance is expected.

American Train Despatchers' Association.

The annual convention of the American Train Despatchers' Association was held in Chicago, Ill., June 17-20, inclusive. Addresses were made by James Davis, member of the War Industries Board; Warren S. Stone, president of the Brotherhood of Locomotive Engineers, and A. B. Garretson, president of the Order of Railroad Conductors. The attendance was large.

The Interstate Commerce Commission.

E. P. Ripley, president of the Santa Fe, speaking of the Interstate Commerce Commission in Chicago recently, said that it is singular that it has never had among its members a railroad man, a business man, a shipper, or a farmer. Once a railroad conductor was appointed, and it is only fair to say that he made one of the best commissioners that we ever had. There has been a notable absence of men specially educated or trained for the work. All these men entered upon the work with an anti-railroad bias, but many have learned that there are two sides to the question, and they have become valuable members. But there are still some who have not seen the light and who stand in the way of finding a solution of the muddle for which they themselves are responsible. The time has come for a more intelligent handling of the railroad problem.

We shall probably be obliged to take over the railroads not later than next January 1, but we cannot take them back under the condit'ons as they have existed heretofore. With the Interstate Commerce Commission regulations there must accompany more responsibility for the payment of our bills, which have been enormously increased by concessions to labor. It is a bad situation and I would be glad if any one could show me a way out of it. It is much easier to criticize the plans of others than to make new plans for others to criticize.

New Double Worm Drive Principle Applied to Lifting Jacks.

A new application of the worm drive principle is being made by the Iron City Products Company in their line of Rees Double Worm Drive Lifting Jacks. In these jacks, instead of there being a single worm gear pinioned to a lifting bar, there

DOUBLE WORM PRINCIPLE APPLIED TO LIFTING JACKS.

is employed the "double worm" principle, in which a right hand and a left hand worm are cut on the worm shaft which meshes with right and left hand worm gears. These gears carry heavy pinions between which the lifting bar, having a double set of teeth on either side, is raised or lowered by the double action of the component sets of gearing, with extremely small effort and without loss of friction due to unbalanced thrusts on the worm shaft or lifting bar. Simplicity and strength mark the construction of the Rees jacks. There are only four working parts in the lifting mechanism, all of rugged proportions—no small parts to get out of order.

A number of different sizes of various capacities, and for various particular uses are made. The design shown will probably be of most interest to our readers. It is known as Model No. 21A. The car and general purpose jacks are made in a number of heights and capacities, rating from 10 to 25 tons, while the inspection model is made in three heights, 9 ins., 10 ins. and 11 ins., all having a rated capacity of 25 tons. Rees double worm drive jacks are safe, powerful and convenient, and represent a very high class tool that is bound to be appreciated by foremen, superintendents and users everywhere.

These jacks are manufactured exclusively by the Iron City Products Co., 7501-7511 Thomas Boulevard, Pittsburgh, Pa., who also have district representatives and jobbing connections in the principal cities.

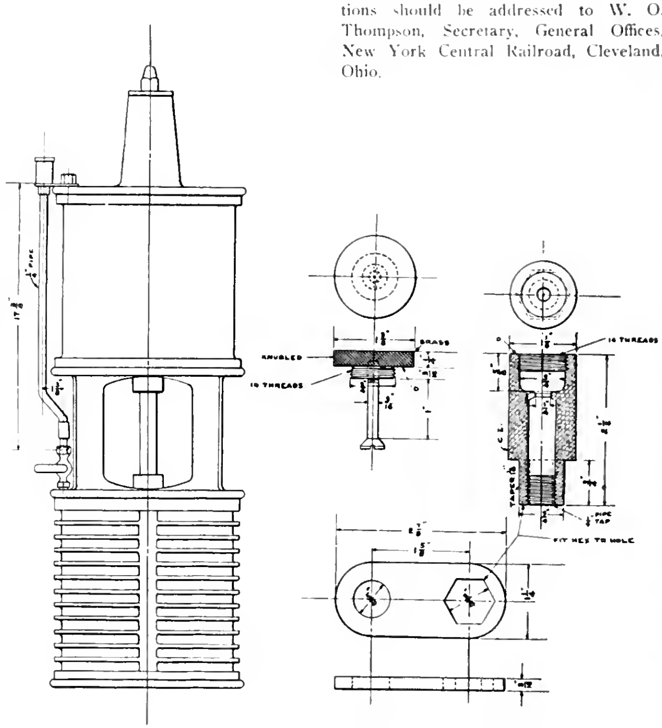
Lubrication Device for Air Cylinders.

By A. C. Clark, Pittsburgh, Pa.

Many passenger engines and several types of the largest freight locomotives are being equipped with two air pumps. The lubricators on the most of these locomotives are provided with means for furnishing oil to one air pump only, and by the use of the device shown in the accompanying drawing there is a considerable saving effected instead of furnishing an additional lubricator.

The drain cock on the top of the lower or air cylinder is closed if the pump is working when being filled with air. One-quarter-inch pipe is used from that point to the brass cup at the top. When unscrewing top, to prevent cup from turning, note the hexagon on the bottom of the cup which fits in 3/16-in. plate, bolted in turn by one of the ten or twelve bolts which secure the top head of the steam cylinder in place. Another novel feature is the pin screwed into the cap. This, of course, must first be placed through cap, and the pin has a small slot in it as shown, so that it can be screwed in tight, having a large end inside, it prevents cap from being lost when it is unscrewed to fill the device with oil.

The device, apart from the saving in the number of lubricators, is appreciated by the enginemen as a labor saver.



DETAILS OF LUBRICATING DEVICE FOR AIR CYLINDERS.

National Institute of Inventors.

The installation of the officers of the National Institute of Inventors was held at the Broadway Central hotel, New York, last month, in the presence of a large assemblage of members and guests. The newly elected officers, to serve until 1920, were: L. J. Wing, president, pioneer inventor of exhaust fans; Carl Schonert, manufacturer of automobile accessories, of Newark, first vice-president; Robert C. Lafferty, architect, New York City, second vice-president; George Houtain, attorney at law, of 44 Court street, Brooklyn, third vice-president; Milton F. Williams, manufacturer of pulverizers, St. Louis, Missouri, fifth vice-president; W. H. Kennedy, recording secretary; Nathan Langer, treasurer; Paul Revere Fay, one of the fighting 69th, executive secretary, and R. Nerenstone, assistant executive secretary. On the Board of Governors to serve for five years were elected: David Moss, New York City; L. Kenner, Ne[illegible] Julius Glantz, New York City, Michael Quinane, Paterson, New Jersey; [illegible] Harding, New York City.

Traveling Engineers' Association.

The annual meeting of the Traveling Engineers' Association will be held at the Hotel Sherman, Chicago, Ill., September 16th to 19th, inclusive, 1919. Communications should be addressed to W. O. Thompson, Secretary, General Offices, New York Central Railroad, Cleveland, Ohio.

Items of Personal Interest

J. J. Corcoran, assistant engineer on the New York Central at Albany, N. Y., has been promoted to chief signal inspector east of Buffalo.

Lamoine Knowles has been made storekeeper of the Chicago, Milwaukee & St. Paul at Council Bluffs, Ia., vice James Harris, resigned.

The Pullman Co. is planning to rebuild its car repair shops near Ludlow, Ky., recently destroyed by fire with loss estimated at about $100,000.

D. A. Ross has been appointed road foreman of engines of the Santa Fe, with office at Temple, Texas, succeeding L. E. Fowler, transferred.

C. S. Gzowski, Jr., has been appointed special engineer to the vice-president of the Canadian National Railways, with headquarters at Toronto, Ont.

Herman F. Noyes, traveling engineer of the Maine Central, has been appointed superintendent of fuel economy, with headquarters at Portland, Me.

G. E. MacDonald has been appointed general manager of the Pacific Great Eastern at Vancouver, B. C., succeeding G. L. Courtney, who has resigned.

G. O. Huckett, master mechanic on the Chicago, Burlington & Quincy lines west, at Alliance, Neb., has been transferred to a similar position at Wymore, Neb.

Charles J. Scudder has been appointed superintendent of shops of the Delaware, Lackawanna & Western, at Scranton, Pa., succeeding J. Grieser, assigned to other duties.

W. J. Harahan, federal manager of the Seaboard Air Line and associated roads, has been appointed federal manager also for the Atlantic & Western, with office at Norfolk, Va.

Claude Farley, general foreman of the Rock Island at Cedar Rapids, Ia., has been transferred to Horton, Kan., and W. K. Smith has been appointed wrecking foreman at Eldon, Mo.

F. S. Kelly, master mechanic of the Louisiana division of the Texas and Pacific, with headquarters at Gouldsboro, La., has been transferred to Marshall, Tex., succeeding R. E. Roe, resigned.

Lieut. Col. Elmer K. Hiles has returned from France and has resumed his duties as manager of the Pittsburgh Testing Laboratories. Col. Hiles was attached to the Fifteenth Engineers.

James McGuire has been appointed roundhouse foreman of the Chicago, Milwaukee & St. Paul at Miles City, Mont., and William I. Owens has been appointed night roundhouse foreman at Janesville, Wis.

D. R. MacBain, superintendent of motive power of the New York Central Lines West of Buffalo, has been appointed assistant general manager of the lines west, with headquarters at Cleveland, Ohio.

Philip Petri, formerly district engineer on the Baltimore & Ohio, Eastern lines, at Pittsburgh, Pa., has been appointed division engineer, with office at Cumberland, Md., succeeding W. T. Hughes, transferred.

R. R. Jackson has been appointed division storekeeper of the Pittsburgh division of the Baltimore and Ohio, Eastern lines, with headquarters at Glenwood, Pa., succeeding T. C. Hopkins, assigned to other duties.

William G. Pearce has retired as president of the American Brake Shoe and Foundry Co. to become chairman of the executive committee. Joseph B. Terbell, vice-president, has been elected president to succeed Mr. Pearce.

S. A. Chamberlain has been appointed superintendent of motive power on the Lake Superior & Ishpeming and the Munising, Marquette & Southeastern railroads, with headquarters at Marquette, Mich.

Major C. E. Lester, formerly master boilermaker of the Lehigh Valley at Sayre, Pa., has been appointed general superintendent of the 19th Grand Division, Transportation Corps, of the American Expeditionary Force.

J. M. Kerwin, master mechanic of the Rock Island at Silvis, Ill., has been transferred to Goodland, Kan., as master mechanic, succeeding C. A. McCarthy, transferred to Cedar Rapids, Ia., as general foreman of the shops.

Albert C. Mann, purchasing agent of the Illinois Central, with headquarters at Chicago, Ill., has resigned to become vice-president of the American International Steel Corporation, with headquarters in New York.

Frank H. Clark, formerly general superintendent of motive power of the Baltimore & Ohio, has opened offices at 15 Park Row, New York, and will undertake engineering investigations, report on railway conditions and operations.

Joseph Chidley, assistant superintendent of motive power on the New York Central Lines West of Buffalo, at Cleveland, Ohio, has been appointed superintendent of motive power of the Lines West, succeeding D. R. MacBain, promoted.

A. M. Traugott, division engineer of the Virginian railroad, with office at Princeton, W. Va., has been appointed acting chief engineer at Norfolk, Va., succeeding F. L. Nicholson, who is resuming service with the Norfolk Southern.

N. L. Garbutt, for the last six years manager of the Line Material Section of the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., has been appointed manager of the Supply Division of the Westinghouse San Franciso office.

C. R. Couchman, tie and timber agent of the Pere Marquette, has been made assisstant purchasing agent and general storekeeper, vice N. C. Foss, resigned, to enter service of the Grand Trunk. W. W. Bracy becomes tie and timber agent, offices at Detroit.

Col. George H. Webb, 16th Engineers, having returned from service in France, has resumed his former position of chief engineer of the Michigan Central, the Chicago, Kalamazoo & Saginaw, and the Detroit Terminal railway, with headquarters at Detroit, Mich.

Theodore Schmidt, car foreman of the Chicago, Milwaukee & St. Paul at Council Bluffs, Ia., has been made general car foreman at Mills City, Mont. Samuel Jenson becomes head inspector at Council Bluffs, and Andrew Thompson becomes car foreman at that point.

Adolfo Wilkinson has been appointed general manager of traffic and Enrique Ferraz chief of traffic and transportation of the State Railways of Argentina, and D. Pio Zaldua becomes general superintendent of stores of the same lines by decrees of the minister of public works.

Dr. Gonsalves Barboza has become director of the Estrada de Ferro Central do Brazil, with office in Rio de Janeiro, Dr. Aguiar Moreira having asked to be pensioned. Drs. Deocleciano de Vasconcellos, Jose Antonio da Rosa and Rodrigo Nunes de Mesquita will be members of Dr. Barboza's staff.

W. L. Robinson, superintendent of fuel and locomotive performance on the Baltimore & Ohio, Western lines, with headquarters at Cincinnati, Ohio, has been appointed division master mechanic of the Illinois division, in charge of Washington shops and mechanical department, with headquarters at Washington, Ind.

A. M. Burt, assistant general manager of the Northern Pacific, has been appointed assistant director of the Division of Operation of the United States Railroad Administration at Washington, D. C., in charge of engineering and maintenance, vice Charles A. Morse, resigned to resume his former position as chief engineer of the Rock Island, at Chicago.

Major Merrill Dunn, vice-president of McCord & Co., Chicago, has received the decoration of Chevalier of the Legion of Honor from the French Government for meritorious services during the war, from

which he has recently returned. Major Dunn was commissioned captain in the signal corps of the United States Army in October, 1917, and assigned to duties in France.

Alfred H. Smith, director of the Eastern region of the Railroad Administration, has resigned from that position to resume his former duties as president of the New York Central, and A. T. Hardin, assistant regional director and also director of the Central district of the Eastern region, has been appointed regional director of the Eastern region, succeeding Mr. Smith.

Colonel R. T. Lamont, president of the American Steel Foundries, Chicago, has been awarded the distinguished service medal for exceptionally meritorious service as assistant to the chief of the industrial division, and for rendering material assistance to the nation's industry in adjusting equitably outstanding contracts in full justice to employers and employes alike.

J. Snowden Bell, the well known engineering writer and associate editor of RAILWAY AND LOCOMOTIVE ENGINEERING, has been in the Western Pennsylvania Hospital, at Pittsburgh, Pa., since the last week in May, on account of injuries received from a fall, but is recovering satisfactorily and expects to be back in New York at an early date and resume his engineering and legal activities.

Lieut. L. T. Burwell and E. C. Zimmerman, both of the New York office of the Q. and C. Company, New York, having received honorable discharge from the war service, have resumed their old positions in the company's service, and are traveling out of New York in the sales department. Lieut. C. M. Brennan is also out of the army service and is located at the Chicago office of the Q. & C. Company.

C. S. Coler, manager of the entire evening school, and director of trades training of the Westinghouse Electric & Mfg. Company, East Pittsburgh, Pa., has been appointed manager of the educational department of the company, and president of the Casein Technical night school, succeeding C. R. Dooley who has accepted a position with the Standard Oil Company to promote educational work in that organization.

Brigadier General William W. Atterbury has been relieved from his services in the army, where he was engaged as Director General of Transportation in France. General Atterbury received the Distinguished Service medal of the United States Army, the French Legion of Honor, and the British Order of the Companion of the Bath. He has resumed his former duties as vice-president of the Pennsylvania Railroad.

W. G. Balph has been appointed manager of the Safety Switch Section of the Westinghouse Krantz Factory, Brooklyn, N. Y. As head of this section, Mr. Balph will have entire responsibility for the sale of all Krantz pruoducts, and in addition will have charge of the extension and development of this very important line to meet the needs of the country for safety switches. Prior to working as salesman in the New York office, Mr. Balph was head of the Fan Motor Division, with offices at East Pittsburgh, Pa.

G. E. Johnson, assistant superintendent of motive power of the Chicago, Burlington & Quincy lines west, with headquarters at Lincoln, Neb., has been appointed superintendent of motive power, with offices at Alliance, Neb. Mr. Johnson's entire railroad experience has been in the company's service and he has occupied almost every position in the locomotive department, including fireman and locomotive engineer. He came from Sweden at an early age and was educated in the public schools at Omaha, Neb., and entered the company's service as machinist's helper in 1896.

Railroad Equipment Notes

The Northern Railroad of France has ordered 50 Mikado locomotives from the Baldwin Locomotive Works.

The Louisiana Railroad & Navigation Company will rebuild burned shops at Shreveport, La., at a cost of $100,000.

The South Porto Rico Sugar Company has ordered 65, 30-ton, all-steel cane cars from the American Car & Foundry Company.

The H. & H. Refining Company, Kansas City, Mo., has ordered 20, 40-ton, 8,000-gal. tank cars from the American Car & Foundry Company.

The Robert Dollar Steamship Company, San Francisco, Cal., has ordered from the American Car & Foundry Company 100 high-side gondola cars for export to China.

The Norwegian State Railways have ordered 18 locomotives from the Baldwin Locomotive Works, including 2 ten-wheel, 6 Consolidation, 7 Prairie and 3 six-wheel switching locomotives.

The Central Railroad of New Jersey has ordered a 36-lever improved Saxby & Farmer interlocking machine from the Union Switch & Signal Company, for installation at Elizabethport, N. J.

Orders have been received by the American Locomotive Company for 10 locomotives for the Nigerian Railways. These are mountain type locomotives; total weight, 133,000 lbs.; weight on drivers, 89,500 lbs.; diameter of drivers, 42¾ ins.; cylinders, 18 by 23 ins.

The Korean Government has ordered 12 Mikado type locomotives from the American Locomotive Company. These locomotives will have 25-in. by 28-in. cylinders, 160,000-lb. weight on drivers, and a total weight in working order of 206,000 lbs.

The French are said to have made good use of the German rolling stock. The trains from Boulogne to Paris now consist of sumptuous German carriages. Most of the goods trucks in use at present in the north of France are British and German.

The Cuban Railroad Company, New York, has ordered 150 40-ton box cars and 25 first and second class passenger, baggage and mail and express cars from the American Car & Foundry Company, Chicago, Ill.

The American Locomotive Company has received orders for twelve locomotives of the Mikado type for the Korean Government railways. These locomotives are among the largest in that country, cylinders 25 ins. by 28 ins., weight on drivers 160,000 lbs., total weight 206,000 lbs.

The United States Railroad Administration has delivered 197 locomotives during May, besides 21 for foreign service, and 2 locomotives were shipped for domestic service by the American Locomotive Company, and 10 foreign and miscellaneous domestic by the Baldwin Locomotive Works.

Of the locomotives delivered during the latter part of May and early in June, the average is about 45 per week, the most popular class at the latest date the switching locomotives in various types and sizes. The Santa Fe type is also coming prominently into service, particularly on the Southern Pacific, having 11 of this type delivered within a period of ten days.

The Pennsylvania Lines West of Pittsburgh will build a group of repair shops at Stark, O., to consist of a locomotive erecting shop, heavy and light machine shops, tank shop, flue shop, wheel and pipe shop, blacksmith shop, firing up shed, storehouse, office building, rest house and shed for the storage of miscellaneous material. Some of these buildings are already under contract, and bids have been requested or will be requested on the remainder. The buildings, with the exception of the rest house, office building and storehouse, which are of brick and timber construction, and the firing up shed, which is of re-enforced concrete, will be of steel frame and brick exterior wall construction and carried on concrete foundations.

Bulletins, Catalogues, Etc.

The Baker Locomotive Valve Gear

The Pillod Company, Swanton, Ohio, has issued a new edition of a pamphlet on the above subject extending to 76 pages. The gear has been frequently described and illustrated in our pages, but it may not be generally known that there are now over 5,000 locomotives in service equipped with this gear, and it is being adopted as standard by a constantly increasing number of railroad companies. Besides complete details of the construction and adjustment of the gear, there is also an illustrated description of the Sentinel low-water alarm, a device that insures against low water with its attending casualties. This device is also rapidly coming into popular favor, which is the best proof of its utility. The pamphlet is finely printed on toned paper and substantially bound, and sold at 25 cents per copy.

Coal Will Cost Less

An official report issued by the American Railway Association states that the cost of coal consumed on American railroads in 1917, under ordinary conditions, would have totaled about $265,000,000, the delegates at the annual convention of the American Railway Association were told, but because of war conditions, the severity of the winter and increased mine prices, the total actually amounted to $401,000,000, an increase of more than 50 per cent. from the previous year. The report said that a substantial decrease for 1919 may be expected as a result of the greatly reduced tonnage handled and the influence of organized effort to promote economies.

Cutting Cast Iron

In discussing the possibilities of cutting cast iron by means of the acetylene blowpipe, a British contemporary states that heavy casting can be perforated in a few seconds by blowing the flame through a wrought-iron tube in which iron wires are inserted. The part to be operated on is first brought to a bright red heat with an ordinary flame and, immediately oxygen at an initial pressure of its atmospheres is admitted, the molten metal is thrown out with such force that the work cannot be performed without asbestos cloths and gloves. Castings 2 ft. thick, it is said, can be perforated in two minutes and large castings removed in pieces by fusing holes in suitable places and allowing the castings to crack as they cool.

Mechanical Coal Pushers

The Locomotive Stoker Company, Pittsburgh, Pa., has issued a new edition of a finely illustrated pamphlet, No. 15, furnishing particulars in regard to mechanical coal pushers for locomotive tenders. As is well known, the fireman should be relieved of the arduous labor of firing the larger type of locomotive. Hence the success of the mechanical stoker, and hence the need of the coal pusher which eliminates this part of the firemen's duties, enabling him to remain in his natural position. It also makes it unnecessary to station men at different points on the division to shovel down coal, and it is also possible to have coal tipples farther apart. The pusher is compact and simple, as well as substantial and durable. The pamphlet gives full details of the construction and operation of the device, and copies of the publication may be had on application to the company's main office at Pittsburgh, Pa.

Gold's Handy Reference

Gold Car Heating & Lighting Company, Whitehall building, New York, has issued a revised and enlarged edition of a reference pamphlet for vapor, steam and hot water supplies for car heating and ventilators. It contains details and illustrations of the company's latest improved specialties, and is especially designed for the use of all employees who may come in contact with the maintenance of car-heating systems, making it easy for them, when ordering repair parts, to ascertain the correct number or letter and thus avoid delay in obtaining the parts required. These devices run up in the hundreds and have all stood the test of actual service. Among the more recent are the Cyclone ventilators, which can be left open in all kinds of weather, absolutely excluding rain, snow, hail, dust, as well as smoke and gas. The electric heaters have also reached a degree of perfection that has been greatly appreciated. Copies of the pamphlet may be had on application to the company.

Railway and Industrial Engineers

J. E. Muhlfeld and V. Z. Caracristi, well known in the engineering world as engineers of wide experience, have issued a prospectus of their incorporation as a company operating in the railway and industrial engineering field. They have associated with them an experienced, competent and reliable staff of experts, and are prepared to serve in the organization, management and operation of railroad, public utility, industrial and manufacturing enterprises as advisory and consulting engineers. They and their assistants are eminently qualified by training and experience to report on inventions, new methods and processes, and in the development of those having merit and commercial value. The company's offices are located at 25 Broad street, New York.

The Young Locomotive Valve Gear

The Pyle-National Company, 1334 N. Kostner avenue, Chicago, Ill., has issued a pamphlet of 48 pages describing and illustrating the details of the Young Locomotive Valve Gear. We understand the descriptive work is from the pen of the clever inventor of the valve gear that bears his name, and it is interesting to note that he is a master of clearness in style. The work is accompanied by studies of indicator cards and valve ellipses, and logical causes are shown for the improved locomotive performance, which, it is claimed, is accomplished by his gear. The analysis will prove of real value, as at first sight the gear seems somewhat involved in its action, but the work very clearly points out the reason of the departure from the conventional valve gears, and the advantages derived from the variations. The latter is borne out by reports from test trials and other data. Copies of the pamphlet may be had from the above company.

Robinson Automatic Connector.

The Consolidated Equipment Company, 17 Battery Place, New York, has issued a finely illustrated pamphlet furnishing details in regard to the Robinson automatic train-pipe connector. The device automatically connects and disconnects the train-pipe lines as the cars are coupled or uncoupled in service, and has the endorsement of the Interstate Commerce Commission, stating in its report that it is a safe and practicable device which, if properly installed and maintained, will meet the need for an automatic connector in general freight service and add to safety in train operation on a railroad using it. It is mechanically simple in construction and composed of few parts which are easily assembled. It is comparatively light in weight, and of ample strength to withstand all shocks to which it is likely to be subjected in ordinary service. Copies of the pamphlet may be had on application made to the company's office.

Davis Brake Beam.

The Liberty Steel Plate Products Company, Woolworth Building, New York, agents for the Davis Solid-Truss and Liberty built-up brake beams, have issued an illustrated circular, showing the construction of the solid truss brake beam which is made by cutting a bar on a line with its length, leaving it uncut at each end; the part of the Davis bar or section intended for the compression member is then shortened by upsetting or compressing lengthwise. The shortening causes the round portion of the bar, which has been severed to move outward, forming the truss-end.

Referendum No. 28.

The Chamber of Commerce of the United States of America has issued a referendum on the report of the Committee on Railroads on remedial railroad legislation extending to 36 folio pages. The document embodies a statement of questions, personnel of the committee, report of the committee, arguments on the negative, together with plans proposed, in comparable form, and federal incorporation for interstate systems. The forms proposed are of special interest, embodying as they do the proposals of the Railroad Administration, the association of railroad executives, the national association of owners of railroad securities, the Railway Business Association, besides proposals of leading experts, including Director General Walker D. Hines. The purpose of the referendum is to ascertain the opinion of the commercial organizations of the country, not to secure the approval of the recommendations voiced in the report. The Board of Directors neither approves the report nor dissents from it. The result of the canvas will be watched with interest.

Railway and Locomotive Engineering

A Practical Journal of Motive Power, Rolling Stock and Appliances

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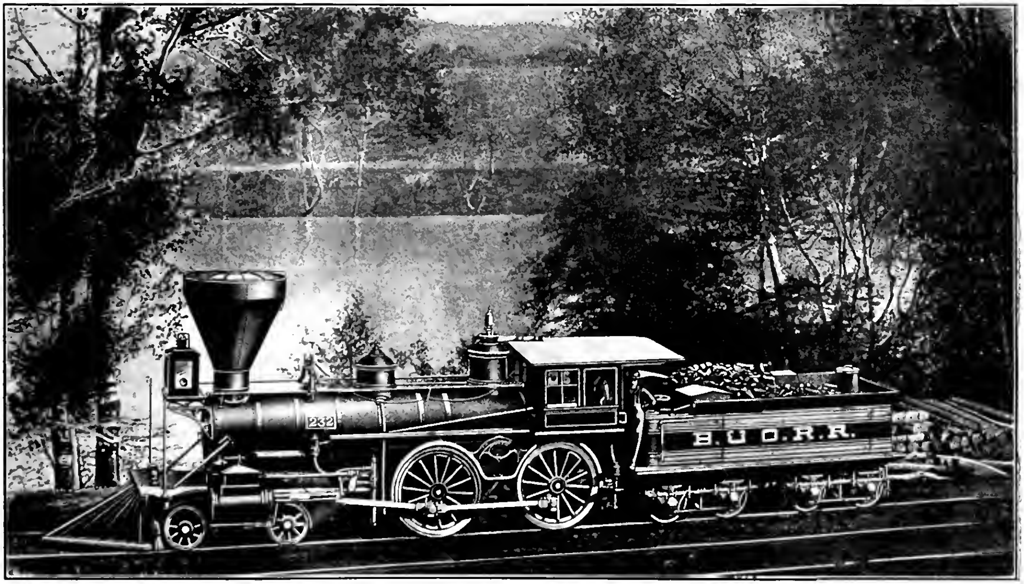
A Mason Locomotive on the Baltimore & Ohio Railroad in 1857

By J. Snowden Bell

The accompanying illustration, which is reproduced from an excellent photograph made prior to 1864, shows engine No. 232, which was one of six built for the Baltimore & Ohio Railroad, by Wm. Mason & Co., of Taunton, Mass., and put in service in August, 1857. The Potomac River and Chesapeake & Ohio Canal appear in the background, and the locomotive and its location will be familiar to the few now living who knew them.

When William Mason began building locomotives in 1852, the ideas of art harmony as applied to locomotive designing appear to have had no place in the minds of men carrying on the work. They labored with some success to produce locomotives that did the work of hauling the trains with fair economy, and they worked out proportions that provided the required strength without carrying a burden of unnecessary material, but no attention appears to have been bestowed upon the outward appearance of locomotives, so far as making the visible outlines harmonious, was concerned. There was a great deal of ornamentation put upon some of the parts, but the effect on aesthetic taste was often grotesque where beauty was aimed at. Elaboration of brass in bands and coverings of domes, sand boxes, wheel covers, steam chests and cylinders with great vagaries of paint on other parts, conveyed the impression one receives from looking at the garments of an overdressed woman. Those were the days when the red smoke stack and vermillion painted wheels were regarded as a mark of distinguishing beauty. It was then considered the correct thing to spend hundreds of dollars on the painting of portraits or picturesque scenes on headlights, cab panels and tenders.



MASON ENGINE ON THE B. & O. R. R. IN 1857

Mason took the lead in making locomotives that were handsome without the

aid of glittering brass and ostentatious painting. Mr. M. N. Forney said of him: "He was a wonderfully ingenious man and combined with his ingenuity a high order of the artistic sense, so that his work was always most exquisitely designed. It might be said of his locomotives that they are 'melodies cast and wrought in metal."

These engines can be correctly characterized as novel and typical, and except as to the improvements of detail which have been developed in later practice, their general design stands to-day unsurpassed by any of the "American" or 4-4-0 type. It was immediately adopted by nearly all the locomotive builders of the United States, and its characteristic features may be stated as comprising the straight, or, properly speaking, telescope boiler, instead of the prior dome or wagon top pattern; horizontal cylinders secured to the frame and to a round smoke box through a cylinder saddle; wide spread truck; elimination of outside frame rails and other excrescences; ogee moulding dome and sand box bases and tops; and a neater and more symmetrical arrangement of link motion and reverse. These engines had 16 x 22 inch cylinders, 60 inch driving wheels, and weighed about 24 tons. Their boilers were 46⅝ inches diameter of smallest ring, 5/16 iron, and had 106 tubes, 2¼ inches diameter, and 11 feet 2½ inches long. The firebox heating surface was 86.5 square feet, tube heating surface 694.5 square feet, total heating surface 784 square feet, and grate area 15 square feet.

The writer's recollection of the Mason engines accords with that of a veteran railroad man, who wrote to him: "I well remember these engines—the neatest, best proportioned, trimmest engines ever built by anybody, and they did their work all right, too." The type has now practically been superseded by the Atlantic, but in its time it was the best for general service, and no better exemplification has ever been produced than the Mason locomotive of 1857.

Work of the American Engineers on the French and Belgian Railways

We have already described in our pages the passing over of 5,000 German locomotives to the Allies. It has taken longer time than was stipulated in the armistice, and after being examined and tested by the American engineering experts it is generally admitted that they are doing as good service as the average French or Belgian locomotives. The great bulk of the locomotives are of the heavier freight type, and the cars include all varieties from the oldest type of third class carriages to the modern corridor stock built for express passenger service. The marks of the German authorities have, of course, been carefully removed. The Prussian eagle appearing on the sides of the cars is covered by a St. Andrew's cross in white.

The lack of material retards the repair of the roads both in France and Belgium. Sections of the light railways particularly have been stripped for miles of every rail, though the ballasting still shows where the railroads were. Dynamiting of rail joints seems to have been the favorite method of breaking up the railroads. It must be admitted that it was the work of experts. This, of course, is expected to be all paid for in the final reparation settlement, but the delay in transportation continues. In the German territory held by the allied army of occupation, conditions, although much congested, are fairly serviceable. The speed of traffic is slow, being below that of the slowest freight train, with the exception of what is known as the Cologne Express, which runs daily between Boulogne on the French coast and Cologne. The working of this train is under military control, and is more particularly for the facility of transferring officers of the Army of Occupation, proceeding or returning from leave. Only a definite number of tickets are issued. All of the train staff are in military uniform. The poor condition of the tracks and the existence of a large number of temporary bridges render high speed impossible, the eastern journey taking about 19 hours and the western journey 21 hours. This train is largely under British supervision and management, but in the meantime the American railway engineers have not been idle. The large and numerous material stores of the American Expeditionary Force located at various points are under a special system of protection, and supplies are handled with all the precision of a high class American railroad.

Photo by Signal Corps, U. S. A.

RAILWAY SPEEDERS CARRYING CHEMICAL FIRE FIGHTING APPARATUS

The accompanying illustration is a reproduction of a photograph taken by the United States Signal Corps, and shows a squad of engineers in charge of chemical fire tanks mounted on speeders on railway tracks running between American supply camps, acting as a special fire brigade. No damage of any importance has occurred by fire in the temporary structures so far, but the Americans are full of the spirit of watchful waiting. The speeders can be rushed from one of the camps to the other in record time. The view is taken near the camp at St. Sulpice, Gironde, France, but the same precaution looking towards safety first exists all along the lines to Germany, and also along the Rhine where the great body of the army of occupation is located.

It will thus be seen that while the most of our engineer regiments have already returned to the United States there are enough left to maintain a good share of the needed work that will likely continue for another year. Out of it all has come an appreciation of the fact that American engineering means and methods have been and still continue to be an object lesson to our allies, and in point of progress and promptitude, combined with a quick initiative the American engineers are an example to their European brothers in arms.

The Storage of Railway Fuel Oil

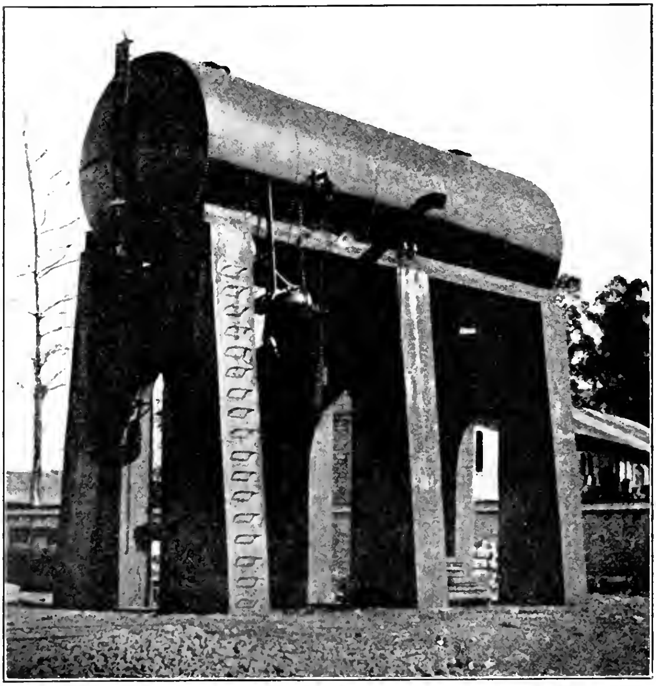
The railway use of fuel and crude oils for the firing of steam boilers on locomotives has spread widely over the country. It is to be assumed that generally the purpose is economy. In many districts, oil is cheaper than coal. But other considerations weigh. When the New York Central and the Delaware & Hudson railroads use oil on certain locomotives, we are to understand that economy is probably not the object in view. These Eastern roads appear to use oil because of the greatly reduced danger of setting fire to the forests through which the trains run. Cleanliness, ease and rapidity with which steam can be gotten up, ease of pushing the boiler, compactness of storage on and off the locomotive—all these are advantages that weigh, and doubtless help to decide cases in favor of oil, where the cost of oil is equal or superior to that of coal.

When a road uses oil in any quantity, it is necessary to provide for storage at convenient points. In general, the storage tanks are steel cylinders; but concrete for oil storage is coming into notice, the difficulty of getting steel during the war having, no doubt, helped to push concrete into view. Whatever the material of the storage tank, the oil, if brought by rail, has to be transferred from the railroad tank car. This is a steel cylindrical shell laid horizontal. The contents of the car may be transferred in two ways—(1) by gravity, and (2) by pumping or its equivalent. In either case, however, the oil may move sluggishly. Fuel oil is rather thick and inclined to move slowly under ordinary circumstances. In cold weather this characteristic will be emphasized. Whatever the reason, it will often be advisable, not to say necessary, to thin the oil in order to facilitate its flow. This is done by heating. The railroad tank may be fitted with a steam coil for the purpose. In such case, the proper connections are made and steam introduced into the coil. If the tank car is without its own steam coil, a portable coil may be let down temporarily into the oil, the coil being in the neighborhood of the intake of the pump. If the point of storage is a considerable distance away, then it may become advisable to heat the oil again as it flows along through the connecting pipe line. That is, it may seem best to pass it through a heating device. Where the discharge from the tank car to the storage tank is to be by gravity, a pipe line may be arranged to carry the oil. The construction of a trough is recommended. When the car stops, it will be located immediately beneath the central part of the car and will naturally be constructed of concrete or steel. Where a suction pump is to be used to get the oil out, the suction end is let down to or near the bottom of the car and the pump started up. The suction piece should be fitted with a swing joint and a strainer.

The storage tank itself may be sunk below the general level or it may be elevated on suitable supports. The writer is not, at the moment, prepared to state that any elevated concrete oil tanks have been erected; but he sees no reason why an elevated oil tank of concrete should not be constructed as well as elevated water tanks of the same material.

The system employed on the Great Eastern Railway, Great Britain, before the war, was to use underground tanks which received their oil directly from the railway tank cars. Apparently, gravity was depended upon to transfer the oil to these underground containers. At any rate, the oil was pumped from them to elevated cylindrical tanks. The oil was transferred to oil cranes which performed the actual service of supplying the locomotives. It is said that a main line locomotive would receive "600 gallons of oil in four or five minutes."

The size of a storage tank will naturally be a little in excess of a multiple of 6,000 gallons, for the reason that 6,000 gallons is the capacity of a regulation tank car. So, then, storage tanks will properly have capacities something greater than 6,000, 12,000, 18,000, etc., gallons. I mention one on the Mexican Railway which has a capacity of some 20,000 gallons. It is a big metal cylinder of five rings of riveted plates. It rests horizontally in a kind of groove provided by a tall concrete (or, perhaps, adobe) pedestal. The pedestal consists in part of three narrow arches of heavy construction. The whole affair has a substantial appearance, and does not seem to be especially objectionable from an aesthetic point of view. Whether the arches are reinforced or not, does not appear. There are wickets let into the concrete of an end arch which provide steps leading up to the tank. There is also another such stair at the other end in the rear, and as will be noted from the illustration, the tank has two manholes, one at each end on top.



OIL TANK ON THE MEXICAN RAILWAY OF 20,000 GALLONS CAPACITY

An alternative means to suction for transferring the oil from the tank car to storage is compressed air. The air is forced in through a connection reaching in through the manhole. The effect is to create a compressed air blanket on top of the oil in the car. This will put all the oil under pressure. It is only necessary to provide a discharge outlet in order to utilize this pressure in getting the oil out. The vertical leg of a discharge pipe line is put down through the manhole. The lower end will properly be at or near the bottom of the tank. When the compressed air method is employed, the joints where the air line and the discharge line reach down through the manhole must naturally be tight ones to prevent loss of air. An advantage of this procedure is that the pressure may be run ~~up~~ beyond 14.7 pounds per square inch. When pure suction is employed, the movement of the liquid is obtained by removing the natural air pressure in front of it, thus giving the air pressure back of it opportunity to become effective. The limit of such pressure is naturally the weight of the general atmosphere, which is at the seashore about 14.7 pounds per square inch. In actual practice, the full weight of the atmosphere would never be attained. However, with a compressed air blanket on top of the oil in the car tank, the pressure may readily be run up. One authority, however, warns us that tank cars are, many of them, tested only to 50 pounds per square inch, and that in consequence, we need to be on our guard. This is good advice.* The blanket of air will exert its pressure impartially in all directions. The result will be that the air blanket will be exerting itself to find a weak crevice in the upper part of the car tank.

The storage tank should have a vent pipe. This properly takes the form of a tube extending vertically upwards from a flange arranged in the top of the tank. It serves a double purpose. When the tank is filling up with oil, it becomes necessary to let the air already in the tank escape. Otherwise it would suffer compression and exert a back pressure against whatever force was seeking to fill the tank. Conceivably, this might be made useful, as this compressed air might later on serve as a means of forcing the oil out of the tank when a locomotive tender was being filled alongside. If this idea were to be utilized, the tank would perhaps need to be made stronger and tighter than is usual.

* Another writer says: "It is stated that tank cars are tested under a pressure of 40 pounds per square inch, but it is wise to use a compressed-air pressure of not more than 10 pounds per square inch." He goes on to state that this pressure would balance a column of oil about 24 feet high. It is doubtful whether 24 feet is really enough for maximum heights of storage tanks for railroads, especially as the 24 feet means the top level of the oil. Thus, in England, cylindrical tanks were employed on the Great Eastern Railway at a level of 20 feet. This surely means 20 feet from the bottom of the tank.

I venture to say a further word on this topic, as the creation of a compressed air blanket may ultimately prove a worthy procedure. This idea has long been in use in private water systems used on country estates and the like. The steel tank, buried under ground, is filled with a combination of compressed air and water. At the time of filling, the air or part of it may exist as bubbles scattered through the water. These rise and go together, so that ultimately there will be a blanket of compressed air over a body of water. This blanket is then utilized to force the water to all parts and levels of the building.

However, the vent pipe serves another purpose besides the provision of an outlet for the air already in the tank. Gases are apt to form when oil is stored. These find an outlet through the tube. If it be proposed to do away with the plain open vent pipe and utilize the blanket of air and other gas to drive the oil, then a safety device is to be substituted in order that the pressure may be kept within limits.

A further question suggests itself. The mixture of air and gases from the oil may very well prove dangerous, especially with certain oils, because of a liability to explode. In view of this consideration, the open vent pipe is the thing to use, unless thorough investigation shows that no explosive mixture is likely to form and become a hazard.

The plain, open vent pipe may be simply a straight tube arranged vertically with a bent piece at the top. This bent piece may be a half circle, in which case the air and gas issuing into the open air will be directed downward and the vertical pipe will, in effect, have a covering. Wire gauze may be used to cover the opening.

Another style of vent is a long vertical tube terminating at the top in a cap. This cap may have various forms. The idea is to cover the tube, but at the same time provide side openings for the exit of air and gases. These apertures may be covered with wire gauze. The object in using the gauze is to prevent fire from traveling back down the vent tube to the interior of the tank. Wire gauze is a well-known means of preventing a flame from passing.

The vent tube may be utilized as a convenient place at which to instal a gaging device for the purpose of determining at any moment the depth of oil in the tank. A simple method of doing this is as follows: A small pulley is arranged at the top of the tube, beneath the cover. It is set so that a wire or thread run over the pulley and allowed to hang vertical will have one strand in the axis of the tube. The other strand is to hang outside the tube where it is accessible. Another pulley may or may not be needed for this. A suitable weight is attached to the outer end. The interior end of the wire is secured to a float. This may be simply a sealed shell of metal, of the shape of a sphere or other convenient form. The weight of the float is to be adjusted so that both strands of wire will be kept taut as the float rises and sinks with the varying level of the oil in the tank. A moment's thought will, perhaps, show that the weight outside will vary its level so as to keep exact pace with the changes of level of the oil inside. Only, the weight will shift in the opposite direction. By arranging a scale alongside of the exterior wire, one will be providing a means of noting the exact changes of level of the oil.

This device shows the depth of the oil and when this has been ascertained, the approximate total of oil then in the tank may be calculated. Or, better yet, calculations may be made beforehand, showing the amounts of oil corresponding, say, to every 6 inches of depth. Tables which may be used to determine the quantity of oil corresponding to foot and inch variations in level have been published by R. T. Strohm for two sizes of tank. The one table applies to a tank 8 feet in diameter which has a length of 28 feet; the other, to a tank 9 feet in diameter and 33 feet long. Both tanks are assumed to lie in horizontal positions. See pp. 100 and 101 of his "Oil Fuel for Steam Boilers."

Mr. C. G. Hall, of the American International Railway Fuel Association, is the authority for the statement: "Oil can be handled from tank cars to storage tanks and thence to locomotives for about 0.005 cent per barrel, while the average for handling coal runs about 5 cents per ton." This statement was made before the war; so that perhaps both figures would have to be increased when making application to the present time. However, the ratio would probably remain the same or else be still more unfavorable to coal. In other words, according to Mr. Hall, it appears that it costs at least ten times as much to handle coal as oil. This is an item that should be considered, especially when the bare cost of the oil appears to equal the bare cost of the coal.

As already suggested, elevated oil tanks are properly constructed of two materials—steel plate and concrete. The following may be regarded as proper thicknesses for the steel plates. If the tank is of one-car size (6,000 gallons), then 3/16 inch is about right for the thickness of the steel shell. For two-car tanks, the cylindrical shell may be given the same thickness, but the heads may be given a thickness of 5/16 inch. For a three-car tank, the cylinder may have ¼ inch plates and the heads ⅜ inch.

The piping connecting tanks and pumps and the like will naturally be of steel. It may be necessary, especially with certain oils, to give more than ordinary attention to pipe joints. Three types of joint have been recommended. (1) The pipe ends are to be given a taper thread. This means that the overall diameter of the pipe at the threaded end will gently increase from the very end as one goes back. The thread with which this is to co-act should also be tapered. This is the Briggs pipe joint and is in general use in the United States for pipe connections. The object of the tapering threads is to provide for absolute tightness. A second method requires that back nuts "be employed to reinforce the sockets by aid of an interposed fibrous ring." The third requires that the pipe ends "be truly faced off exactly at right angles to the axis of the threading" and that "a compressible, but thin, washer of soft metal or fibre" be "interposed between the ends of the abutting pipes. Such pipes meet together in the sockets like artesian drive pipes." However, if only the usual methods have been followed and leaks develop, caulking may prove a satisfactory remedy. In any case, when a threaded joint is made, a pasty material may be spread over the threads as a means of making the joint very tight. This pasty material should not be anything that will dissolve in petroleum. A proper paste may be made by mixing together suitable quantities of glycerine and litharge powder.

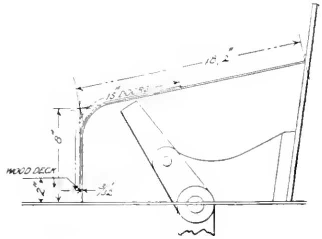
Where concrete is to be used for the construction of the tank itself, the latter may have almost any shape desired. In general, reinforced concrete will be cheaper. The reason for this is that when concrete is used without reinforcement, it is usually necessary to employ it in large amount. The wall thickness and the floor thickness will be considerable. If the tank is to be an elevated one, it will be almost imperative to use reinforced concrete for still another reason. Concrete is strong to resist crushing pressures; but it is weak to resist a pull. Steel reinforcement is employed largely for the purpose of correcting this defect in this material. Crushing strains are resisted by reinforced concrete in part by the concrete itself and in part by the steel; but the pulling strains (i.e., strains in tension) are resisted almost altogether by the steel. Now, a tank buried in the earth with the support of the soil underneath and all around the sides, is one thing; the same tank set up on legs is quite a different thing. The liquid contents press down on the floor and press horizontally, all around, against the sides.

There seems no good reason why the elevated reinforced concrete tank for fuel oil should not become quite common. Similar tanks are in use for water—why not for oil? There is no trouble whatever in getting the proper strength. When water tanks of wood staves are built, it is common to use steel hoops to resist the bursting pressure on the sides. This bursting pressure is nothing at all at the top level of the water; but it steadily increases with the depth. With every foot of depth the pressure becomes about 7 ounces greater per square inch. But fuel oil is lighter than water; so that the pressure increases at a less rate—about 6 ounces per square inch per added foot of depth. Similarly, the weight on the floor of the tank will be less than the same depth of water, its amount corresponding to the side pressure at the lowest level. So, then, with pressures only 6/7 of those of water, there is no reason why the elevated reinforced concrete tank for oil should present any real problem in so far as the pressure question goes.

There is, however, another matter which has to be considered. Will the oil penetrate the concrete? It is said in effect that if the interior surface is brushed over with a solution of silicate of soda, there will be no trouble with the heavier oils, assuming that the concrete is a dense mixture. This satisfactory experience has, it seems, been realized with underground tanks. For the cases where the oil is light, a treatment with fluor silicate of magnesia is mentioned as more effective than the silicate of soda.

Grate Shaker Shield.

There is in use on the locomotives of the Delaware & Hudson Co. a very simple



DETAILS OF GRATE SHAKER SHIELD

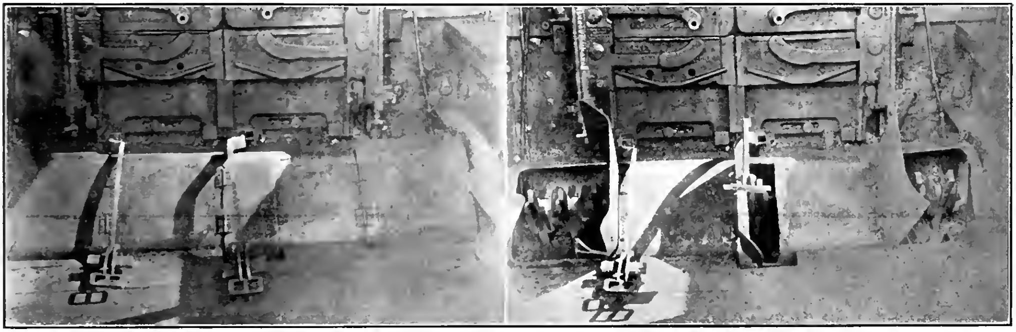
arrangement for covering the grate shakers and openings at the back end of the boiler and front of the deck, especially the opening between the boiler and the deck.

During the ordinary work of firing more or less coal is spilled and much of it finds its way through these openings to the track. The object of the shield is to prevent this waste. It consists of a plate metal shield 3/32 in. thick shaped as shown in the section and fitted with doors over the levers for the shaker bars. These doors are shown in the open and closed positions in engravings.

When the doors are closed the shield fits closely against the boiler head and any coal falling upon it slides back and lodges on the footplate, whence it can be swept back into the tender or gathered up on a shovel to be put in the furnace.

As will be seen it does not interfere at all with the action of the door openers, and the doors open wide enough to be well out of the way when the grates are to be shaken.

This design of coal saver can be made for a comparatively small amount and will have soon paid for itself.



GRATE SHAKER SHIELD SHOWING CLOSED AND OPEN POSITIONS

Snap Shots

BY THE WANDERER.

I have often wondered how it could happen on the X, Y, Z that the train bulletin at a terminal would so often have a train marked up on it as 10 or 15 minutes late, and that same train would invariably roll in from 20 to 30 minutes behind time. It seemed strange that it should always lose so much time after the latest report. But I caught on the other day. I was on an X, Y, Z train that left a division terminal late. In a run of 79.8 miles it made up 5 minutes. It so happened that I got off at that first stop and there was the usual bulletin of train 21, 10 minutes late. Now I had been on that train 21 all night and I knew that it had not been less than 20 minutes late for several hours. The query is how and why that bulletin announcement of 10 minutes? What had the despatcher, the station agent, or the railroad to gain by what must have been a deliberate lie by some one? Perhaps the clamoring of an impatient public may have been temporarily appeased, but the recoil in ill-will because of the deception is really worse than the direct shot. No wonder that the sentiment of hostility to the railroads is hard to appease when they will not even tell the truth about the punctuality of their trains. It is a little thing, to be sure, but it is the accumulated mass of these little things that is responsible for the demagogue and the trouble it is possible for him to make.

I was in a large car car shop last winter that was cold, very cold, and things were not moving very rapidly. It brought forcibly to my mind the old idea of many by-gone proprietors that a cold shop was rather a good thing. Men were not disposed to loiter if they were cold; they would hustle to keep warm and a big output would be the result. These owners of cold shops seem to forget the invariable law of the corelation and conservation of energy. In this case it is the man. He is capable of developing a certain amount of energy. If a large percentage of that capability is expended in keeping warm, by just that amount is a subtraction made from his effectiveness. Remove this demand upon him and the output is correspondingly raised. In short the proprietor has to pay for keeping his men warm and it remains for him to decide as to whether it is cheaper to do it with coal or by human exertion.

It takes a long time for some people to learn to stand an egg on end, and all of this talk about bad rails, and broken rails, and high carbon rails and the mystery of breakages harks one back to old-time construction before designing began. If the parts of a locomotive of forty years ago broke they were strengthened by putting in more metal and making them heavier, and often the strengthening was of such a character that stresses were increased by the added weight and the last condition of that part was worse than the first. It took many decades to develop the I section side rod and many are the wrecked cabs and mutilated men that the old slab rods are responsible for. But some stresses are difficult to calculate and still more difficult to measure, though there are many that do not fall into this class.

When the Quebec bridge failed, thousands of dollars were spent in testing full-size girders and models in order to determine actual as compared with calculated strength. But a rail, that's a simple matter of a dispute between buyer and seller. A case of Katy did and Katy didn't. "You made me put too much carbon in my steel and then used excessive wheel loads," and, "If you would use care in the manufacture the rails wouldn't fail," with neither party knowing very much as to what actually happens or is likely to happen. Fortunately the spirit of scientific investigation that is abroad is making itself felt in this as in other matters and it is probable that before long there will be some very definite knowledge in existence as to what is occurring in the track and to it, so that real reasons may be given for failures, instead of so many that are to a certain extent surmises.

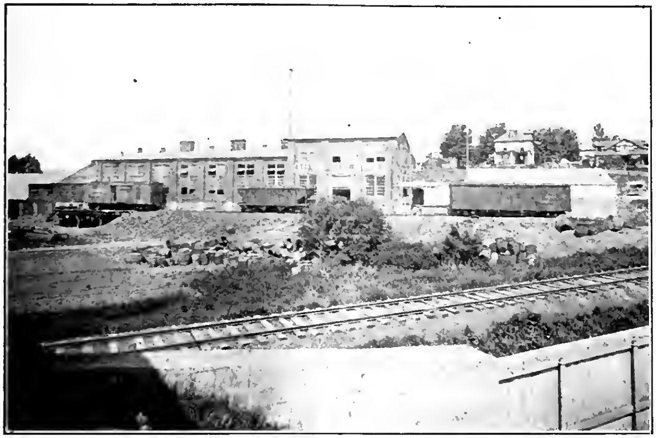
Once in a while I happen across a model plant and I went into the engine room of such an one the other day. There was a 1,000-horse power cross-compound engine at work, with a steady hum and click of its Corliss valves that was the ideal of sleepy monotony. But the engineer was worried, and he asked me to put my ear against the lagging of the low-pressure cylinder and listsen. I listened and heard the faint click of the piston rings at the end of the stroke, as they evidently slipped the smallest fraction of an inch at each reversal. Not much to worry about, but it was all there was. In the engine room there was not the faintest suspicion of a leak, and from all appearances the engine might have been driven by electricity, air, or its own belt. And that belt, broad and straight and running as true as a die, evidently cut from the center of the hide and no stretch. It was the same in the boiler room. There was the silence of death, not a particle of steam escaping anywhere, a pile of coal neatly run along the front, no ashes, no smoke, no dirt, and the fireman spending most of his time reading the technical papers and books treating of his trade. The company furnish the papers and forbid his reading novels and the daily papers when on duty. They give him Pocahontas coal to burn and expect him to make himself efficient, which he is. They, the company, say it pays, and I guess it does, for of all the cheap steam horse power I ever ran across that was the cheapest. They say, too, that it costs almost nothing to keep things up to the standard, but it is always expensive to bring them up when they are allowed to fall. As I write this I am sitting in a foreman's office of a big railroad machine shop. In a near-by corner there is a steam pipe which is making itself known by the loud hissing and the clouds of steam that obscure the corner, and I am wondering whether that is an example of the economical operation of the road. It would cost a little to stop a leak that has been clamoring for days for repairs. If it typifies the general run of work, then that road could afford to pay a man a good big salary to stop its little leaks.

I was in two foundries a short time ago. They were not so very far apart, were producing the same kind of goods, employing the same class of labor, under almost identical conditions. In each there were elaborate facilities for toilet and baths; hot and cold shower and tub baths, free to all, ample for all, but in neither case was there any compulsion as to their use. In one instance they were utilized up to capacity, and the man was an exception who did not have his bath before going home. In the other the accommodations were actually getting dusty from disuse. There was, however, one great apparent difference in the appointments. In the foundry where the baths were used there were doors to the rooms so that each man bathed in absolute privacy. In the other the rooms were simply stalls and open to public gaze. A man at the bath was in full view of his fellows. I wondered if that was the reason for their lack of use. Possibly it might be worth while trying the experiment of putting doors on the stalls, for perhaps even a moulder's helper may have some desire for a privacy at times that is at least worth cultivating and catering to.

Years ago in the days of light machines and light cuts it was a matter of economy on the part of the employer and pride on the part of the blacksmith to forge close to finished dimensions. Now it is so much cheaper to pay for stock, cut it off and waste it that close forging does not pay, even in very, very many cases it does not pay to forge at all, but rather cut down from rolled stock. It is probable that this has had a deteriorating

influence on stock, for metal is not now given the work that would improve it, and the working down to low temperatures is, at least, not always done, and so the high finishing temperatures that prevail leave the metal coarse grained and not as strong as it might be. Still, on the other hand, the improved qualities of the modern steels more than compensate for this, leaving a net gain to the user.

Apropos of shopwork, it so happens to have been my good fortune to have wandered about a bit and to have incidentally picked up an idea or two of more or less value. And in this wandering I have often been struck by the absence of information as to details of costs, especially in foundry work. Usually foundry costs are lumped in at so much a pound and the owner finds himself charging to costs the same rate for stove plates and base or rubbing plates where one may weigh pounds to the other's tons. They don't cost the same and every foundry man knows it, but he doesn't know how to differentiate, so everything goes together as "hounds and greyhounds, mongrels, spaniels, curs are yclept all by the name of dogs." An engineer was telling me of his experience in this matter where by the introduction of an exceedingly simple method of accounting he was able within twenty minutes of the weighing of a pouring to put a cost price on every individual casting in a large job shop foundry, and that with no extra expense for clerical labor. The result was somewhat curious, however, in that he gained the reputation of being erratic, if not crazy. By basing his prices on his costs his quotations would range from 1½ to 15 cents per pound, while his competitor across the way stuck to one steady figure, and everyone knew what to expect. But everyone came to my friend just to see what he would say, with the result that in a season of depression he got all the heavy work, rolled up his tonnage and put the foundry on a paying basis, while the light stuff, in which there was no money, went elsewhere. He was quite willing to accept the reputation with the work, and let people say: "Well, that man Blank is certainly crazy, for he quotes all over the lot; you may get a bargain and he may try to rob you, but its worth asking as to what he will do." I wonder how many railroad foundrymen who charge themselves the same prices for cylinders, oil boxes, brakeshoes and center plates have any idea as to what they actually cost. Do you?



BOSTWICK-LYON BRONZE WORKS, WAYNESBORO, PA.

Bostwick-Lyon Bronze Works.

Among the enterprising firms that are rapidly increasing their output and extending their facilities the Bostwick-Lyon Bronze Company, Waynesboro, Pa., is bidding fair to continue its progressive career of expansion. The company has already earned an enviable reputation in the specialties for which it has become noted. These include lead-lined journal bearings, and all kinds of brass castings for freight and passenger cars, as well as a general variety of brass castings for steam locomotives.

The capacity at present is over 60,000 lbs. daily, and new machines are being added to the plant which will enable a larger possible output in the near future. All the bearings and castings manufactured in the company's works are manufactured on special molding machines, so that the castings are absolutely true to pattern.

The accompanying illustrations show front and rear views of the plant, which extends to 450 ft. in length by 150 ft. in width. The president of the company, W. S. Bostwick, was formerly connected with the Magnus Company. C. A. Lyon is secretary and treasurer.

REAR VIEW OF BOSTWICK-LYON BRONZE COMPANY'S PLANT

Danger in Open Switches.

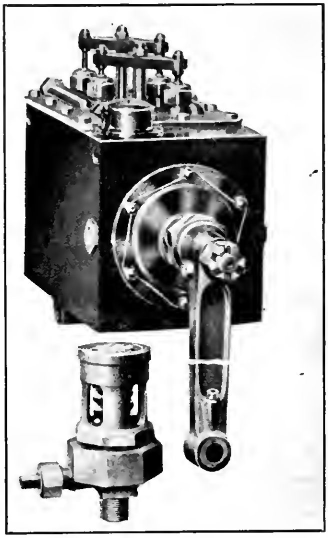
The Pennsylvania Department of Labor and Industry has called special attention to the increased number of deaths as a result of shock by employees coming in contact with charged electrical equipment. Unprotected open switches seems to be by far the greatest danger. The enclosed switch with all "live" parts covered up and the cover grounded is the only safe kind of an electric switch which should be permissible with dangerous voltages in any establishment.

The Schlack's System of Locomotive Force Feed Lubrication

At the recent exhibit of the Railway Supply Manufacturers' Association at the first annual convention of the American Railroad Association, Section III, Mechanical, held at Atlantic City, N. J., among other recently introduced devices the Schlacks system of locomotive force feed lubrication attracted unusual attention. The merits of the device are already well known, as nearly 1,000 locomotives are equipped with it, and the reports of its effectiveness and reliability are of the most gratifying kind. The fact that it requires no kind of attention is in itself its most outstanding and valuable feature. It is a well-known fact that the locomotive engineer has already more than enough minor details to attend to. There is a limit to mental as well as to physical activity, and the perfected self-acting, self-sustaining lubricator is an important step in the right direction, and it would be a gratifying relief if more of the intricate mechanism of the modern high-powered locomotive were equally self-controlling.

As we have already noted in our pages, the lubricator lever is operated by a link connected to an extension on the combination lever of the locomotive valve gear. This link actuates a ratchet that turns a cam shaft in a reservoir that holds about eight pints of oil. The stroke shaft, moved by a vigorously constructed cam, carries two pumps, one for each right and left steam pipe, so arranged that they deliver a constant and exact supply of oil from the reservoir into the steam at every revolution of the drivers. The reservoir is attached to the back head of the valve chamber. The length of the lubricator lever that controls the amount of oil delivered is determined by a formula based on the valve travel, at the average running cut-off, and the diameter and stroke of the cylinders.

This is not all. At the delivery end of each oil pipe leading into the steam pipes there is a diaphragm check valve screwed into the steam pipe of the locomotive. This maintains a constant oil pipe pressure in excess of the maximum working steam pressure, irrespective of any steam pipe pressure fluctuations. This insures a constant and equal supply of oil entering the steam at the same instant that a drop of oil is injected into the oil pipe by the pump. On stopping the locomotive the oil in the pipe remains trapped between the reservoir and the diaphragm check valve, so that when the locomotive is again set in motion the supply of oil commences immediately. Even should the locomotive remain idle for many days the oil remains in the pipe ready for service at the first movement of the wheels. This is of real value, not only because it is not necessary to start any kind of lubrication some time in advance of starting the locomotive, but also because of the assurance that the lubrication begins automatically with the movement of the engine, and it is not to be expected that it is within the range of mere manual experience to gauge the exact time at which a lubricator should be started, as the starting moment may not be exactly known in advance, and the incidental loss either by starting the lubricator too soon or too late is entirely avoided by the use of the device referred to. As is well known, any excessive oil when carbonized changes from a lubricant to an adhesive abrasive, causing increasing wear of moving parts and sticking of packing rings as well as clogging of ports and exhaust nozzle. It also causes difficulty of removing valves, and often reduces cylinder clearance so as to make dangerous any lengthening or shortening of the main rods, because of the liability of the piston knocking out a cylinder head.



THE SCHLACK'S LOCOMOTIVE LUBRICATOR

As to the calculation of amount of oil used in different kinds of service it may be briefly stated that if a passenger locomotive, with 75-in. drivers, receives five drops of oil per minute per cylinder, while running 60 miles per hour, and, if a freight locomotive, with 63-in. drivers, receives four drops of oil per minute per cylinder while running 40 miles per hour; they both receive one drop of oil every fifty-third revolution, and they both make 106 valve and piston strokes, depending for lubrication on the oil received on the first two strikes. The extent of the error in thus lubricating both locomotives is appreciated when one realizes that the freight locomotive, with 20 per cent more valve and cylinder area to lubricate, is given the same amount of oil.

The improved system injects an amount of oil in proportion to the valve and piston travel area, at every revolution of the drivers, resulting in perfect lubrication with a greatly reduced total amount of oil consumed per trip, besides rendering it inadvisable to use valve stem and piston rod oil or swab-cups. It has been repeatedly shown that a hundred miles to the pint of oil and a hundred thousand miles to the set of cylinder packing rings can be made with the system on modern heavy superheated passenger engines with records proportionate to the diameter and stroke of the cylinders and the diameter of the driving wheels.

It may be added that the oil in the reservoir is kept at a practically constant temperature by a thermostat controlling a steam supply through a small pipe against the boiler under the lagging from the fountain in the cab. Extra feeds to the cylinders are not necessary. Oil is injected into the steam pipe sufficiently back of the valve to permit the oil to be thoroughly mixed in the steam, so that if a little steam is used in drifting the same oil impregnated steam that lubricates the valves also lubricates the cylinders. It will thus be seen that in addition to its efficiency in meeting the requirements of the service the device requires no attention from the engine men further than refilling the reservoir, and in point of economy it has the crowning advantage of lubricating per unit of work done, and not per unit of time.

Electrification of Belgian Railways.

The electrification of portions of the Belgian railways has been approved by the Belgian government, and several expert electrical engineers have been instructed to submit plans for the electrification of the line between Brussels and Antwerp, and Brussels-Luxembourg, to be followed immediately with plans for an electric line between Brussels and Ostend. Work will be commenced in 1920. The current will be supplied from overhead wires on the third-rail system.

Filling Cavities and Putting on Parts by the Oxy-Acetylene Process

By J. F. Springer

The oxy-acetylene procedure enables one to add metal at points where it may be needed. The torch may, in fact, be called with some propriety a "putting on tool," because it may be used, contrary to most tools, with the purpose of putting on additional metal.

There is perhaps no way in which a torch may be used in railway shops that is more useful than this. For example, a blow hole is discovered in a casting. The casting may be new or it may be old —the blow hole does not add to its value. In fact a blow hole may constitute, at times, a big reason why the whole casting may need to be scrapped. This may be exceedingly expensive. For example, here is a new casting right from the foundry. It appears to be all right. It is put under the planer and faced off, say, on two opposite sides. Next it is taken, say, to the turning lathe and a considerable amount of work is put upon it. Then, it may be, it is put in a drill press. After a lot of holes have been drilled, the workman suddenly finds he has struck a big blow hole and reports to the superintendent. What is now to be done? The casting can't be used with a big defect in a face. Nevertheless, a good deal of money will be lost, if it has to go to the scrap pile. The cost of producing the casting and the cost of the planer, lathe and drill work will all be lost. Besides, time may be pressing. The casting may be needed at once. Take another case. Here is an old steel shaft. It is proposed to change its diameter and alter a number of things, and then use it in the reconstruction of a disabled locomotive. Suppose, now, that a good deal of the proposed machine work has already been done, when suddenly the lathe tool opens up a hidden cavity. Money and time will be lost, if the work has to be scrapped.

The oxy-acetylene process often comes in and solves problems such as these. Blow holes and other cavities and depressions may often be filled satisfactorily. At other times, the results will not answer. Let me explain. The process is perfectly competent to fill up a big or a little cavity, if the workman can get at it. In general, then, there is no trouble about filling a hole with metal. However, it is doubtful if the metal put into the cavity is quite as perfect as that which surrounds it. There are cases, very many of them, too, where it will not be necessary that the filled-in spot shall have all the strength of the surrounding metal: a solid filling of good material will be sufficient. In such cases, the process will be invaluable. There are other cases, however, where the cavity is located at some vital spot where the utmost strength and quality are required. Under such circumstances, it will hardly be wise to do anything else than send the casting to the scrap pile, and start again. Probably, the majority of cases are of the former variety. Let us use the process to get us out of our troubles in these and forget the others.

The first thing to do about a cavity in a casting is to get rid of all unsound metal near by and clean out the hole. The cold chisel will be useful in both cases. Let everything unsound be chipped away and let the interior of the hole be cut all over the surface for the purpose of exposing absolutely fresh metal. Sometimes, the sand blast may be used, either to do all or a part of the work. The tools to use will suggest themselves by the character of the job.

Once the hole is thoroughly clean and all unsound metal removed, the work becomes identical with an ordinary welding operation. That is, the walls of the hole must, spot by spot, be brought to the melting point. New metal in the molten state is mingled with the old. That is, a little of the new is added to a little of the old. But always the rule is to be remembered that both old and new must be molten at the time when the one is dropped onto the other. Similarly, as the hole is filled and new is added to new—this is also done little by little, and the rule is to be kept in mind that the metal in place must be molten as well as that which melts from the rod. If these directions are carried out precisely, the cavity may be expected not only to disappear, but the new lump to be perfectly united to the old and without weak places within itself.

If the casting is of gray iron, Norway iron or an American equivalent may be used as filling material. However, if the work is to be machined later on, across the cavity and its filling, it will perhaps be better to go to more trouble. The reason is this. It is the silicon that is mainly responsible for gray cast iron being soft and capable of being cut on the lathe. It is thought that the excessively high temperature of the oxy-acetylene torch burns out more or less of the silicon when the casting of gray iron is being welded. Consequently, if one used merely pure iron to fill up a cavity, this would not put silicon back into the walls of the hole. These walls might therefore be films of white iron. If trouble is found to result from using pure iron as a filling material —that is, if there is difficulty in machining because of hard flakes or films in the walls of the cavity—then one remedy is to use a special gray cast iron for the filling material. The bars of gray cast iron are to contain more silicon than is usual, in order to have enough for themselves and some to spare for the walls of the hole. In a great many cases, however, pure iron will doubtless prove quite satisfactory.

The casting may be of steel. In this case, pure iron is a filling material that may be expected to give pretty good results. It seems better, however, to use precisely the same material as the work, if possible. That is, the filling may come from bits chipped off of the casting itself or be secured otherwise. Cast iron may be used as a filling material, but if machining is to be done afterwards, it will be well that this cast iron shall contain an excess of silicon, to compensate for loss during the filling operation. A few drops of copper are understood to make a steel weld flow, but also to introduce excessive hardness.

The railroad shop may have to deal with work where a knob or other part is missing. This will oftener occur with castings, perhaps, than with any other work. In such cases, it frequently happens that the part can be replaced with the aid of the oxy-acetylene torch. That is, the torch may be employed as a "putting on" tool. However, this procedure is to be used with caution.

The reason is principally this. The part may be built up and the subsequent finishing to shape may be done in good style, but the metal in this new part may lack the high degrees of quality possessed by the work itself. Thus, a gear tooth that has been broken off and destroyed may be replaced by building up a new one in the rough and then chiseling and filling it to exact size. But, the capability of this tooth to resist everything one of the other teeth is able to resist may be lacking. It will be well, however, not to be too rash. It may very well be that the new tooth is amply strong enough to perform all the duties it is expected to perform. In such cases, one will often choose to use the oxy-acetylene procedure and build up a new tooth rather than wait for a new gear wheel from some distant point.

I wish to say a word of caution, but I do not want to give the impression that the "putting on" process is generally useless. Not at all. A decision must be reached, at the time, whether to use it or not. If full quality and full strength are

needed, then do not use the oxy-acetylene procedure. But, if some considerable abatement on strength and quality is permissible, the process may cover the matter very acceptably.

The part that is to be built up may be a knob, a lever handle, a boss, a lug, a gear tooth, or the like. Whether the main body is of cast material or not, the first thing is to prepare the surface by chipping, filing, grinding, or otherwise. The object is to get a surface showing fresh clean metal. The torch is now applied at the point of beginning, and the surface at that spot brought to the melting point. New metal from the rod is now melted onto the molten metal of the work. Here, as almost always, the rule is that melted metal is added to melted metal. The whole surface is gone over and new metal added. Then a second layer of new metal is put on and on this a third and so on. But, always, it is to be molten metal to molten metal. The part is gradually built up. Naturally, it will be a rather rough affair. It is now to be brought to size. Whether it will be simpler to use hand tools or power-driven machine tools will depend upon the case in hand. A wise operator will have the finishing in mind when building up the part. The kind of metal to use will be open to his choice. It will not always be necessary, even that the added part shall be identical or approximately identical with the main body of the work. With proper care, however, the new part may be made as good as the rest of the metal.

In railroad work, it may happen that a welding repair will have to be carried out inside of a casing of some kind. That is, it may be necessary as a first operation to cut away a part of the case in order to expose the job. In such cases, the part cut away will ordinarily be replaced with the aid of the torch. The metal may be cut away with the cold chisel or otherwise. Naturally, one will so locate the cut and give it such form as to facilitate the subsequent process of putting the piece back again.

Human Efficiency.

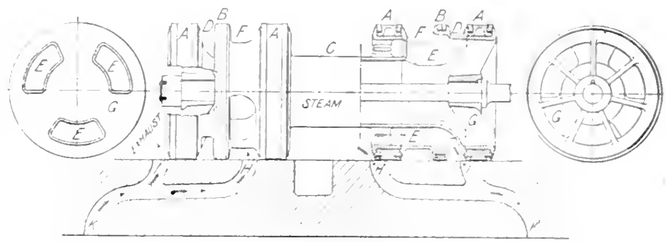
Efficiency is the relation existing between the total units of expended energy and the amount turned into useful work. The competent man achieves in a given time a greater total of useful work than the inefficient. The energy expended by each in a working day does not differ very materially, but the effect of their application does, and herein lies the divergence. It is training and skill which increase the ratio of the useful to the total. In a highly-trained individual there is neither fumbling nor waste effort—every movement counts. He sifts the actions which matter from those which are wasted, and thereby spares himself useless effort.

Double-Ported Piston Valve

The Allen, or trick valve as it is known in Europe, has long been considered as one of the most efficient means for increasing the capacity of plain slide valve engines because it doubles the port opening, thus enabling the steam to gain quick and free access to the cylinder and raise the initial pressure up to that of the boiler.

There have been some difficulties in the way of doing this with piston valves because of the necessity for a special cylinder construction. It will be remembered that the double-ported valve can be used on the plain slide valve engine with no other change than cutting away the valve seat so that steam can enter the valve when it overtravels the seat.

A piston valve with the Allen ports has been designed for the standard locomotives, and is illustrated in the accompanying engraving. The simplest form of piston valve is a spool with a set of packing rings at each end which correspond to the lips of a plain slide valve. With this, as with the plain slide valve, there is but one port opening in the valve seat for each end of the cylinder and the double opening is obtained with the Allen valve by carrying the steam from one end of the steam chest to the steam port at the other through the valve itself.



A DOUBLE-PORTED PISTON VALVE

The double-ported piston valve is more complicated and requires a special arrangement of the cylinder ports for its use.

In the first place it carries three sets of packing rings at each end, or six sets in all, and there is a double port in the steam chest leading to the cylinder. The sets designated A are the main packing rings, and serve to open and close the ports as they travel over them. The sets marked B are to separate the steam from the exhaust cavity in the valve. The valve shown is for inside admission, and steam is always present in the space C. From C the steam also always has free access, through the passages E, to the space D.

The spaces F correspond to the D space in the ordinary slide valve, and are always open to the exhaust through the hollow central portion of the valve G. The exhaust passages from the steam chest, it being understood, lead off from ends of the valve.

The cylinder has a double-ported connection with the steam chest, as shown in the engraving. Here the valve is shown moved from its central position, so that steam is being admitted through the port H from the steam space at the centre of the valve. At the same time the steam is admitted to the connecting port I from the auxiliary space D to the port I, which unites with H and enters the cylinder at K.

At the same time the valve, at the opposite end of the cylinder, has uncovered the ports I and H, and the steam is escaping, as indicated by the arrow, out and into the exhaust spaces at the end of the steam chest. Thus a double width of port opening is obtained.

The Alaska Railroad.

The Alaska Railroad is now nearly completed, and traffic is maintained over more than three-fourths of the line from Seward to Fairbanks, a distance of 471 miles. Seward is an ice-free port. Branches bring the total mileage to over 550. An extensive territory rich in mining and farming is being opened up. Two coal fields containing vast areas of high-grade bituminous coal will be a great acquisition to the Pacific Coast, which is lacking in coal. Extensive lignite fields also will supply the interior country with fuel for industrial and domestic purposes, displacing wood, which has been rapidly disappearing from around the more settled districts. The opening of the road will be of incalculable benefit to settlers in Alaska and doubtless will induce a large influx of new settlers.

The Macleod Company.

The Macleod Company, Cincinnati, O., has issued a new descriptive catalogue of their Buckeye line of weed burners, ground thawers, heating torches, and similar specialties manufactured by them.

Mallet Articulated Locomotive for Pennsylvania Lines West

The Baldwin Locomotive Works have recently delivered ten Mallet locomotives of the 0-8-8-0 type to the Pennsylvania Lines west of Pittsburgh. They are intended for heavy pusher and hump yard service, and are designed to develop a tractive effort of 100,000 pounds, which is indicative of the severe conditions that they are designed to meet. The maximum grade in the hump yards on the Pennsylvania Lines is 3½ per cent, but these new Mallets are designed to work on grades as steep as 5 per cent and on eighteen degree curves.

They differ somewhat from the standards of the Pennsylvania railroad, and where that difference occurs they follow the standards of the builders.

Among these differences is the use of a conical wagon-top boiler with a radial-stayed firebox instead of the Belpaire. At the front end of the crown sheet there are three rows of Baldwin expansion stays, and the arch is supported on five tubes. The dome is very low and the pension hanger so that the curve of motion of the upper end of the latter is reversed from that of the link, while at the rear the center of the reversing arm is ahead of the hanger so that the motion of its upper end lines in the same direction and partially parallel to the curve of the link, a condition that necessitates a change in the adjustment of the two gears in order to produce an equalization of the cut-off.

The steam distribution to all cylinders is controlled by piston valves 14 inches in diameter, and the Simplex intercepting valve is used, with an auxiliary high-pressure exhaust direct to the stack.

Heat-treated steel is used for the crankpins, connecting the side rods and driving axles. The latter being hollow bored. All of the driving wheels carry flanged tires.

The equalization of the rear group of wheels is continuous on each side of the locomotive. In the front group the springs of the leading wheels are cross cast steel frame, and the tank is so designed that a water scoop can be subsequently applied, if desired. It is of the eight wheel type, with a capacity of 10,000 gallons of water, and 20 tons of fuel.

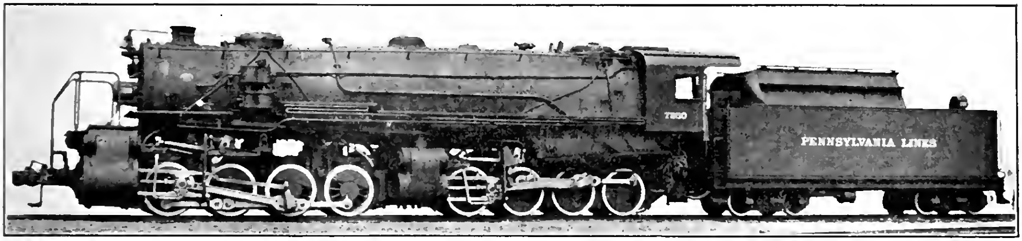
The table contains the leading particulars of these locomotives, and shows them to be among the largest and heaviest of their type thus far built.

Gauge, 4 ft. 8½ ins. Cylinders, 26 ins. and 40 ins. x 28 ins. Valves, piston, 14 ins. diam.

Boiler—Type, conical. Diameter, 88⅛ ins.; thickness of sheets, 1 in. and 1 1/16 ins.; working pressure, 225 lbs.; fuel, soft coal; staying, radial.

Fire Box—Material, steel; length, 144⅛ ins.; width, 96¼ ins.; depth, front, 87½ ins.; depth, back, 68⅜ ins.; thickness of sheets, sides, ⅜ in.; thickness of sheets, back, ⅜ in.; thickness of sheets, crown, ⅜ in.; thickness of sheets, tube, ⅝ in.

Water Space.—Front, 6 ins.; sides, 4½ ins.; back, 4½ ins.



MALLET 0-8-8-0 TYPE LOCOMOTIVE FOR THE PENNSYLVANIA LINES. BALDWIN LOCOMOTIVE WORKS, BUILDERS

feed water is delivered in at the top of the boiler. A working pressure of 225 pounds per square inch reaches about the upper limit of present-day practice in locomotive work. The locomotive is fired with a Duplex stoker. The throttle is fitted with an auxiliary drifting valve.

The high tractive effort is obtained partly by the small diameter (51 inches) of the driving wheels, and this has necessitated the placing of the low-pressure cylinders at a slight angle of 1 in 35 in order to secure a sufficient clearance above the top of the rail.

The Walschaerts valve motion, operated by the Ragonnet type B reverse gear, is used for both high and low-pressure systems. A close examination of the illustration will show, however, that the method of radius bar suspension for the two gears is different. At the front the reversing shaft pivoted back of the sus- equalized, while those of the remaining three pairs of wheels are equalized on each side.

In accordance with recent Pennsylvania practice the cab is comparatively short, but there is plenty of room. The steam turret is set immediately in front of the cab and the connections are led back into it.

Sand boxes are located just ahead of the cab and back of the smokebox, from which pipes are so led that sand can be delivered at the front or rear of each group of wheels.

The height of the boiler is such that there is insufficient clearance on top of it for a bell which was, therefore, placed on a bracket occupying the place of the usual headlight bracket at the front of the smokebox while the headlight is set on a bracket beneath it and located at about the center line of the boiler.

The tender is built with a one-piece,

Tubes.—Diameter, 5½ ins. and 2½ ins.; material, steel; thickness, 5½ ins., 0.148 in, 2½ ins., 0.120 in.; number, 5½ ins,, 52; 2½ ins., 209; length, 22 ft.

Heating Surface—Fire box, 273 sq. ft.; combustion chamber, 76 sq. ft.; tubes, 4639 sq. ft.; firebrick tubes, 42 sq. ft.; total, 5030 sq. ft.; superheater, 1406 sq. ft.; grate area, 96.3 sq. ft.

Driving Wheels.—Diameter, outside, 51 ins.; center 44 ins. Journal, main, 10½ ins. x 14 ins.; others, 10 ins. x 14 ins.

Wheel Base.—Driving, 40 ft. 1½ ins.; rigid, 14 ft. 9 ins.; total engine, 40 ft. 1½ ins.; total engine and tender, 78 ft. 8½ ins.

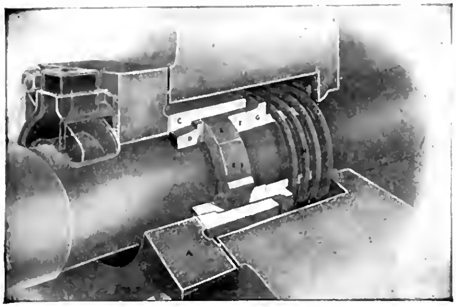
Weight.—On driving wheels, 458,140 lbs.; total engine, 458,140 lbs.; total engine and tender, about 650,000 lbs.

Tender.—Wheels, number, 8; wheels, diameter, 33 ins.; journals, 6 ins. x 11 ins.; tank capacity, 10,000 gals.; fuel, 20 tons; service, pusher, freight.

Improved Piston Rod Lubricator and Packing

The Q & C Company have recently developed a new form of piston rod lubricator and packing that is exceedingly simple and efficient and does away with every possibility of the packing being pinched down on the rod by an over-exertion on the wrench handle in screwing up or fastening the gland.

The lubricator shoe rests in a retainer bolted to the face of the gland, and fits loosely in the retainer, having about one-eighth inch play all around so that it rests on the rod and is free to adapt itself to any movement of the latter. It is filled with curled moss to hold the lubricant. Curled moss is used for this purpose for several reasons: it will not pack down and become bedded in the bottom of the lubricator and thus obstruct the flow of the oil, nor will it be drawn out through the oil hole in the bottom of the lubricator and, by getting caught by the piston rod, be drawn beneath the packing and thus cause heating as waste would be apt to do. And finally the capillary action is sufficient to draw the oil up from the pockets at the side of the lubricator to the oil hole at the center, through which it can flow down to the rod. Thus, from a purely theoretical standpoint it ought to be an efficient lubricator and its work in service shows that it is. It has demonstrated its ability to make from 30,000 to 50,000 miles before it becomes necessary to renew the rings.



DETAILS OF Q & C PISTON ROD LUBRICATOR AND PACKING

It is estimated that the lubricator shoe will ordinarily last about two years, and that the holder with ordinary care should last the life of the locomotive.

While the lubricator can be used with any form of gland or packing, it is associated with the packing shown in the engraving and made by the same company.

The peculiarity of this packing is that it is held tight against the rod by steam pressure, and the spring shown at the back serves only to hold the parts in place.

The cylinder head is bored out to take the outside diameter of the packing and of sufficient depth.

All parts of the packing are made in two pieces with the exception of the retaining sleeve C. This is made in one piece and, in order to put it in place, the piston rod must be taken out of the cross-head. It is turned to slip easily into the cylinder head and bored out to take the packing parts proper, that is, the retaining sleeve bushing D, the packing ring E, the packing shoe E-1, and the back packing ring F.

These three sets of rings are made in sections. The parts D and F, are made in two pieces each, and when the parts are brought together they can be entered in the sleeve and fit loosely on the rod. The parts E and E-1 are in two pieces each so that the four pieces are uses to form the complete ring. The joints of the three sets of rings are made to break with each other so that there is no longitudinal leakage of the steam.

The spring stop G has a bevel face bearing against F so that the latter is prevented from lifting from the rod. The spring H has a tension merely sufficient to hold the parts in place and prevent longitudinal movement under the action of the piston rod. The outward thrust of the spring passed through the rings to D which is held by its lip bearing against the shoulder turned on the inner face of C. And C has a bearing against the gland.

Steam enters the packing chamber from the cylinder and circulates freely over the rings, bushing and sleeve. Of course it has the same access to the space between these parts and the piston rod. But as the outer surfaces of the rings are greater than the inner, the excess of pressure on those surfaces forces the parts against the rods and makes a tight joint. But the instant the throttle is closed the pressure is relieved and the engine drifts without any pressure being exerted on the rod. So that the packing is purely steam actuated without the spring having any influence on the actual tightening of the parts.

Leakage past the gland is prevented by a copper wire ring packing that is inserted between the gland and the cylinder head as shown.

Thus no exertion on the tightening wrench can have any effect on the packing, which is free to act under the influence of the steam as it is designed to do.

A Turntable Extension.

One of the objections that is sometimes raised to the purchase of heavier locomotives than those in service is that they will be too long to be handled on existing turntables. This objection was met temporarily a few years ago, by J. J. Connelly, the superintendent of motive power of the Duluth, South Shore & Atlantic Ry., who designed an exceedingly simple method of turntable extension by which locomotives, with wheel bases longer than the table, could be turned. It consists of two heavy bars, drawn to a tapering edge at one end, that are laid on top of the rails with the taper end towards the center of the table. They each have a lug extending down on the inside that lips beneath the head of the rail. These bars are held out by cross connections that are pinned in place so that the whole forms a rigid overhang beyond the ends of the turntable rails.

The locomotive is backed on from the side farthest from that at which the connection is attached and the rear truck of the tender is run up and out on the extension. With the tender light, the engine balances when the tender truck is on the extension and the front truck wheels of the engine are back about six inches from the end of the table, when it can be turned without any difficulty and the engine run off front end first.

A TURNTABLE EXTENSION

Canada's Fuel Problem.

The *Canadian Enquirer* stated that officials of the government of Canada, such as those in the Geological Survey, Department of Mines, the Commission of Conservation, and other organizations, have knowledge of existing conditions and of practical means by which much of the fuel stress may be relieved To carry out these measures of relief and to place Canada in a reasonably independent position with respect to fuel will take time; but there is no doubt that if matters are dealt with in a broad statesmanlike manner, and the necessary encouragement of financial and other assistance is given to those who are competent, Canada will, at a minimum of effort and expense, be relieved of a menace with respect to her coal supply which threatens not only her economic life, but the well-being of a large proportion of her citizens.

By co-ordinated efforts by communities, savings may be effected by staggering the hours of closing of factories, by the adoption of the skip-stop system for street railways, by daylight-saving legislation, by the enactment and enforcement of wise laws, designed to eliminate the wastes resulting from the smoke nuisance.

In manufacturnig establishments, savings will be effected by the more efficient use of light and power, by the elimination of uneconomical plants and processes by the installation of means to use more economical fuel for direct heating, by the substitution wherever possible of hydro-electric for steam-developed power, and by standardization.

By the electrification of steam railways, especially if operated by hydro-developed power, enormous savings in fuel consumption may be made by the reduction of the amount of coal to be hauled, by the saving of energy resulting from the regeneration of electricity by improved methods of braking, by the reduction of the number of buildings and divisional points due to the greater radius of action of electric locomotives, and where fuel-power is employed, by its economical production in large, modern, generating stations. Canada is looking ahead to great development in the near future in the electrification of steam railways.

In all such efforts to attain the efficiency possible by intelligent saving and co-ordination, Canada may be relied upon not to fall short of her privileges. Recognizing that the days of the widespread use of anthracite are numbered, her bituminous coals and lignites will be subjected to by-product and other manufacturing processes with the object of producing a satisfactory and clean-burning fuel. Canada does not desire to ignore the march of progress in these fuel problems, nor will she be backward in effecting economies for the prevention of needless fuel and power wastes.

Exports of Steam Locomotives.

Each month of the present year shows a steady increase in the number of steam locomotives exported from the United States to foreign countries, and indications point to a continuation of this gradual increase by reason of the orders already on hand and the prospective outlook is of the most encouraging kind. The report furnished by the Bureau of Foreign and Domestic Commerce for May, 1919, is as follows:

Countries.	Number.	Dollars.
France	4	189,800
Italy	45	2,115,000
Canada	4	40,656
Costa Rica	14	796,600
Guatemala	1	2,100
Mexico	2	20,188
Cuba	1	23,700
Dominican Republic	1	16,900
Brazil	4	157,000
Chile	1	18,650
China	3	107,257
Russia in Asia	11	495,000
Philippine Islands	2	6,500
Belgian Kongo	4	51,200
Total	97	4,040,551

Fast Runs.

It is generally admitted that as manufacturers appear to have reached a limit as to the strength of rails, the increase of weight of rolling stock has tended to restrict speeds. The Pennsylvania limits the speed of its passenger trains to 70 miles an hour in general, with lower limits in certain localities, and the Baltimore & Ohio has limits of about 60 miles per hour. The following are among the leading schedules regularly maintained: Philadelphia & Reading, Camden, N. J., to Atlantic City, N. J., 55.5 miles; average speed per hour, 60.6 miles. Philadelphia to Jersey City, 90.2 miles, average speed per hour, 55.2 miles. Pennsylvania, North Philadelphia to Harrisburg, 103.9 miles, average speed per hour, 50.9 miles. New York to Chicago, 908.7 miles, average speed per hour, 45.4 miles. New York Central, New York to Chicago, 976 miles, average speed per hour, 48.8 miles. The diameter of driving wheels is usually not less than the maximum speed in miles per hour.

The Association of Railway Supply Men.

The Association of Railway Supply Men are arranging to provide exhibits at the annual convention of the International Railway General Foremen's Association which will be held at the Sherman Hotel, Chicago, Ill., September 2 to 5, inclusive. The Supply Association has furnished exhibits at these conventions for the last fifteen years, with the exception of the last two years, by reason of the war. The attendance is expected to be unusually large this year, as the government has officially sanctioned the General Foremen's convention. The car foremen and other railway shop mechanical men are being invited. There is an active demand for exhibit spaces, the charges for which, as usual, are $25.00 for single space, 6 ft. by 6 ft. Double space, 6 ft. by 12 ft., $40.00. This space charge is the Supply Association's source of securing funds to meet the contingent expenses incident to this convention. Allotments of space may be secured by communicating with Harlow A. Varney, Secretary and Treasurer, 314 McCormick Building, Chicago.

Canadian Engineering Standards Association.

The Canadian Engineering Standards Association has recently been incorporated, with head office at Montreal. The chief objects of the association are to co-ordinate the efforts of producers and users for the improvement and standardization of engineering materials, and to prepare and promote the general adoption of standards in connection with engineering structures, materials and other matters and things, and from time to time to revise, alter and amend the same. The following distinguished professional men are listed as the incorporators: Sir John Kennedy, Dr. Robert Ruttan, Dr. John Bonsall Porter, Richard John Durley and Henry Hague Vaughan, all of Montreal. The operations of the corporation are to be carried on without share capital.

Master Car and Locomotive Painters' Convention.

The annual convention of the above association will be held at the Hotel La Salle, Chicago, Ill., beginning on Tuesday, September 9, 1919. The committees appointed to report on various subjects in 1917 were continued during the time in which the meetings have been suspended

Railway Accidents in Great Britain.

Reports showing the number of casualties occurring in train accidents last year on British railways show a decrease of over 5 per cent as compared with the records of the previous year, and over 10 per cent. less than the average of the ten years preceding the war period. The total casualties for the year were 870 killed and 4,184 injured.

New Siberian Railway.

The government of Admiral Koltchak, it is said, has decided to begin the construction of a railway from Krasnoufimsk (west of the Urals) to Tomsk, Western Siberia (a distance of over 800 miles). This line, which is intended to relieve the Siberian Perm-Samara Railways, should greatly contribute to the development of the productive forces of Siberia and the Urals.

The Traveling Engineer and Fuel Economy.

Considerable time, thought and labor has been given by the mechanical and other departments of the railways to the conservation of fuel, and the result of this study has produced very gratifying results. R. J. Buswell, road foreman of engines of the Santa Fe, has some original ideas on how the traveling engineer can best aid in fuel economy. In his opinion, the road should be divided into districts and certain grades of coal furnished for each district, and the same grade of coal, if possible, should be furnished at all times for that district. The location of the mine and grade of coal should be taken into consideration when furnishing coal for certain districts. If this were done the men in the roundhouse could draft all engines to burn a certain grade of fuel to the best advantage, and the enginemen would learn to handle this coal to the very best advantage and get more heat units out of it than they can if they have to handle two or three different grades or kinds of coal. The coal furnished should be clean, pure coal with as little iron or clinkering matter in it as possible, so that clinkers would not stop up space intended for the admission of air.

The roundhouse foreman, general boiler foreman and road foreman of engines should make a specialty of knowing how to draft engines properly on their respective divisions. Every engineer and fireman should know how many heat units can be gotten out of a pound of coal when properly burned and how many heat units are lost when coal is improperly burned, also how many cubic feet of air it takes to burn a pound of coal properly. If he understands this he can tell by the condition of his fire whether he is getting the heat units out of the coal or not, and, if he is not, then the fire should be put in shape immediately to get the benefit of all the heat there is in the coal.

Enginemen, roundhouse foremen and boiler foremen should be furnished with small books giving them the number of heat units in a pound of coal when properly burned, also the number of heat units which are lost when coal is not properly burned; the amount of air it takes to burn a pound of fuel properly; the laws of combustion and the waste of coal from poor firing; loss of coal through pops blowing, as well as the overloading of tanks. The long-stroke fellow should have some attention, also the fellow with lots of steam leaks, as well as the man with valves blowing and cylinder packing blowing.

An engine with valves improperly set will waste more fuel in one trip than we can save with a scoop shovel in a month, for an engine which does not have proper steam distribution in her cylinders is a greater source of waste of power than anything else, and coal or oil is the source of all our power; hence the necessity for having the roundhouse force give the matter of setting valves especial attention. The fact that an engine exhaust sounds square does not necessarily mean that the valves are properly set and that she is getting the proper distribution of steam. It is necessary to know that the engine is taking steam at the proper point, and getting an equal cut-off in both cylinders and is letting loose of the steam at the proper time.

Carmen can be of great assistance in fuel economy, especially on locomotives, by keeping down all train-line leakage, knowing that all brakes are released (both air and hand) before the train is allowed to leave the terminal, that all brake shoes have proper wheel clearance and the slack is not taken up too tightly, also by knowing that the dumps on all hopper bottom cars are securely fastened so no leakage will be allowed to occur. This applies also to coal cars with railings on the side.

Another factor which he believes will add greatly to fuel economy is keeping regular men on regular engines, as unquestionably a man who is familiar with a certain locomotive can get better work out of it than if he were given a different one each day to work with. In addition to this each engineman takes greater pride in keeping up his engine if he is regularly assigned than he does when engines are placed in a pool.

Test of Automatic Train Stop.

The Bureau of Safety of the Interstate Commerce Commission has issued a report of the tests of the automatic train stop of the National Safety Appliance Company. The apparatus has been installed on the Western Pacific Railroad at Oroville, California, for the past four years, and another installation, with some changes and improvements, was recently made on the Southern Pacific between Roseville and Sacramento, California. The train stop is of the magnetic induction type, employing permanent magnets in both track and locomotive equipment, and an electromagnet for nullifying or neutralizing, when desired, the effect of the permanent magnet forming a part of the track apparatus. The tests were made for the purpose of demonstrating whether or not it was feasible to transmit by magnetic induction an impluse of adequate magnitude and force from the permanent track magnet to the locomotive, and whether such means was sufficiently reliable.

At Oroville, 1,636 tests were made, which are classified as follows: correct operations, 1,534; unsatisfactory operations, 38; safe failures, 28; false clear failures, 36. The additional tests on the Southern Pacific were made mainly for the purpose of operating the apparatus on trains moving at higher speed. In conclusion, the report states that:

"While as a whole the tests made are not considered conclusive, it has been demonstrated that, with the exception of one of the locomotive-control valves used in the tests, the locomotive apparatus, so far as could be determined, operated as intended, and whenever actuated by the track-magnet impulse it accomplished the functions for which it was designed; further, that the transmission of a magnetic impulse, from a permanent magnet installed on the track to locomotive apparatus designed to be controlled and actuated thereby is both practical and feasible. The fundamental principles upon which this system are based have therefore been demonstrated to be sound and practicable; but the available working limits, as well as the reliability of the transmission and control of the actuating impulse, remain to be fully established. For these purposes further development work, as well as more extended trials under practical service conditions, are necessary.

"Among the features requiring further attention are the selection and use of track magnets of proper characteristics and composition for the service required; the proper proportion and operative relation of electromagnet, track magnet and locomotive-control valve magnet must be definitely determined; the available working limits with respect particularly to rates of speed must be definitely ascertained, and a liberal margin of safety must be assured. Data should also be acquired as to the retentivity of the magnets to be used and their dependable working life under service conditions.

"The tests thus far made, records of which are available, should be of material assistance and value to the proprietors of this system in its further development and in adapting its principles to the conditions and requirements of practical railroad service.

"In view of the results obtained under the conditions surrounding these tests, it would appear that this device has much inherent merit, that a more extensive installation should be made where the real value of this system can be more fully demonstrated."

Combustion.

J. T. Anthony, vice-president of the American Arch Company, 30 Church street, New York, is the author of the latest bulletin issued by this enterprising company. It treats of the "Fundamentals of Combustion and Air Supply," and is the third of a series of excellent treatises on the scientific analyses of combustion, particularly as it occurs in the modern high-powered locomotive. The bulletin should be in the hands of all interested in the subject, and copies may be had on application to the company's office.

A Gasoline Burner

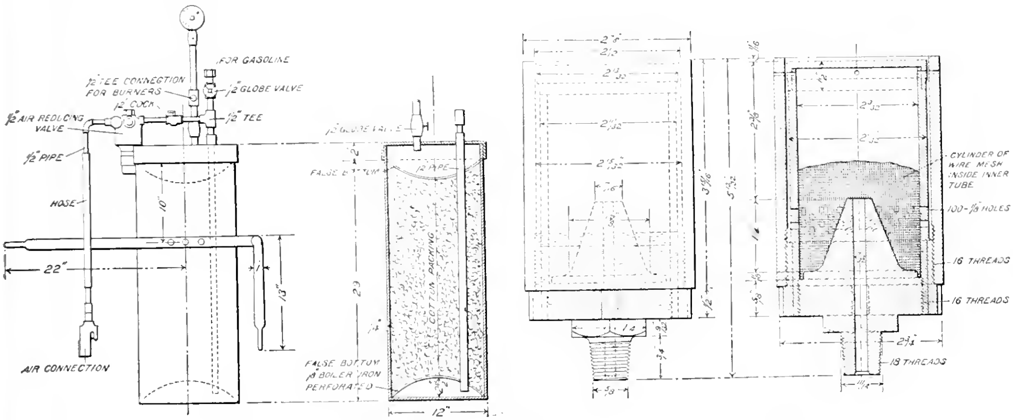
The accompanying engraving illustrates a very convenient and effective gasoline burner for treating metal or removing paint. For heating metal the burner may be made to the sizes indicated on the engraving. For burning off paint the dimensions may be reduced to one-half of those given. The whole outfit consists of a tank and burner.

In order that it may be portable, a tank 12 in. in diameter and 29 in. long is a convenient size. It must be strong enough to withstand an internal air pressure of 25 to 30 lbs. per sq. in. It is provided at top and bottom with a perforated false bottom of 1/8 in. boiler plate that leaves a space between the false bottom and the heads of the tank. The space between the two perforated plates is snugly, but not tightly, packed with cotton. A 1/2 in. pipe extends through the top head and down through the perforated plates and cotton to the space at the bottom. This pipe is connected with suitable valves and cocks so that it can be used not only for filling the tank, but for admitting compressed air for operation. From the top head of the tank there is led off a 1/2 in. pipe fitted with a pressure gauge for indicating the pressure of the burning mixture and a tie for a pipe connection to the burner.

The air admission pipe is fitted with an air reducing valve so that the pressure of compressed air furnished can be cut down to from 10 to 15 lbs. per sq. in., a matter that can be regulated by the pressure gauge on the outlet pipe.

The burner is formed of a solid base of brass screwed into an iron pipe into the interior of which a cylinder of wire mesh is inserted. The tube is perforated with 100 holes 1/8 in. in diameter, and outside of it is a heavy tube leaving a space of about 1-16 in. between its inner surface and the outside of the inner tube. This space is narrowed to about 1-32 in. for the annular space at the top, and it is through this space that the flame is projected.

The method of operation is as follows: The cock in the air supply pipe is closed and the globe valve opened. Gasoline is then poured in at the top of the pipe until the cotton packing is saturated. The globe valve is then closed and the cock opened and compressed air admitted to the bottom of the tank. As the air rises through the cotton packing, which thus becomes a carbureter, it takes up the gasoline and issues from the top of the tank and goes to the burner as an inflammable mixture, which may be burned as it leaves the annular space at the top of the burner. The fire is prevented from flashing back into the burner by the fine wire mesh surrounding the inner tube, which is thus converted into a Davy safety lamp reversed, in that the flame is outside the lamp and the combustible gas is inside instead of the reverse, as in the running safety lamp.

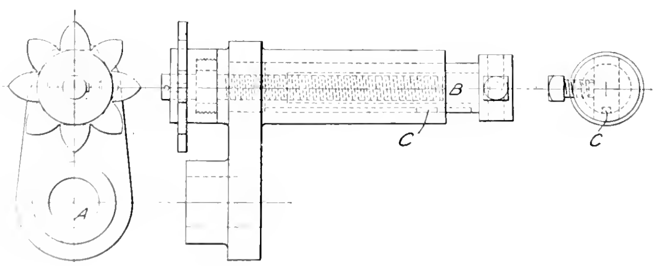


DETAILS OF GASOLINE BURNER FOR METAL HEATING OR PAINT REMOVAL

Device for Machining Lifting Shaft Journals.

The machining of lifting shaft arms for the Stephenson link motion and other similar pieces where a long projecting arm prevents the tool port from being brought close to the work, is always troublesome and usually involves the use of some special appliance. The one shown is intended to do this work by the rotation of the tool rather than the work and consists of a device for accomplishing this.

The hole A is threaded to fit the lathe spindle and the distance out to the center of the tool holder may be varied to suit the requirements of the work for which it is intended. This carries the tool holder B which is prevented from turning by the feather C. The cylindrical portion of the tool holder is threaded for a screw that carries a star for turning it. This star is turned by a trip on the fixed portion of the lathe. The tool is held by the slot and set screw. When adjusted to the depth of cut the whole is rotated by the spindle and fed by the star. Meanwhile the work may be supported on the lathe centers or in any other convenient manner.



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Announcement.

We are pleased to announce that Mr. George L. Fowler has joined the editorial staff of RAILWAY & LOCOMOTIVE ENGINEERING. Mr. Fowler needs no introduction to many of our readers. He has contributed extensively to the railway press, and is a recognized authority on railway engineering subjects, particularly those relating to mechanical department matters. He will be no stranger to the routine workings of an engineering journal, as he was long connected with the editorial staff of the *Railway Age* and other railroad publications. Mr. Fowler is a highly valued addition to our staff and we bespeak for him the favorable consideration of our numerous friends.

The New Era of Labor.

At the Detroit meeting of the American Society of Mechanical Engineers a paper was presented and discussed on the general relations of employers and employes that voiced a sentiment that was widely promulgated during the period of the great war. It was to the effect that the entrance of the United States into the struggle had lifted the nation and the individuals comprising it above the sordid claims of self-interest and shown that the real end and aim of both was to benefit humanity as a whole. In short, it was the embodiment of service for others.

That all selfish motives have not been killed cannot be denied, but the attitude taken by the members who spoke at Detroit was to the effect that the time has come for a co-operative effort that has not obtained in the past. That it is not only the employer who must be willing to grant that the welfare of his employes is a matter of vital interest to him, but the employe must realize that the business welfare of the concern for which he is working is a matter that concerns him very closely.

Heretofore the employe, and through him the labor organizations, have been far more interested in hours of labor and wages and limitations of output than they have in the promotion of their own efficiency. In fact, personal efficiency is a thing that has received but scant consideration, because it has been assumed that the output must reach a certain figure, and that the less each individual produced, the more individuals there would be employed, and, consequently, the better the conditions for labor in general. The point overlooked was that the lower average output per worker, the higher the cost to the consumer, and the less the demand, with a corresponding reduction in the working force. While a high productive capacity lowered prices, stimulated the demand and thus more than made up any other difference by increasing the number of workmen required, and thus automatically raising wages.

In like manner the same rule holds in railroad service. The time has come, as the result of government operation of the railroads, perhaps, when the public has had it driven home to them that rates that will compensate for services rendered must be paid by shippers or a deficit will result, and that a country's transportation cannot be carried on under a constantly increasing deficit. And here is where the railroad man is interested.

If costs of transportation are artificially increased, as by the carrying of a useless man in the crew, or the payments of exorbitant overtime charges, then freight rates will have to be increased. It does not require that a man be an expert in business transactions to know that freight charges have a very important influence on sales; and, if they are too high, there are no sales, and then, if there are no sales, there is no freight, so that the very movement which the unthinking railroader looked upon as a matter of special class benefit to himself, acts as a boomerang to curtail his own activities.

We are bound together by ties that cannot be cut or disregarded and the sooner the whole world of labor and capital realizes this the better, and because the railroad man is engaged in a different sort of productive activity from the man who builds the engines and cars which he handles, he is in no way freed from the bonds which attach him to his fellows in all walks of life.

One of the speakers stated that in a discussion of the introduction of scientific management into shops with the presidents of four labor organizations he had presented the point that hitherto trade unions had opposed scientific management and every other means designed to increase output, and that, therefore, employers who had established relations with trade unions were at a disadvantage in open competition with open shop employers. Then that as soon as co-operative management and ownership was introduced and it was seen that the employes were to reap the benefits of increased output, it was up to these same employes to adopt scientific management to increase the output. These officers unanimously agreed that on that basis they were for scientific management. And so with the general acceptance of the right and even the necessity for collective bargaining, and with a realizations that a grab-all-in-sight game does not redound even to the ultimate advantage of the grabber, but that each and everyone owes a debt to the community, there will come a much smoother running of affairs.

And to this must be added the same standard of honor for both parties to the contract, and that neither side be at liberty to treat it as a scrap of paper having no weight in conscience or in law.

Shop Economies.

While the conservation of fuel has been receiving the attention of an army of experts all over the country and much economy effected, it must be admitted that it is well to look into other uses of materials, less important, perhaps, but also capable of being affected in the right direction if the determination of saving is intelligently applied. The war period has shown that the difference between existing and former conditions is that it is not now a question so much of cost as in many cases of limited supply. Take the case of files: The old-timer got a new file as a rare treasure, not as a matter of course, and the way he cared for it would put the average mother to shame. He started it on brass, because if it were used on harder material to begin with the fine edge is stripped in a few minutes, while quite a long time was needed to reduce its cutting ability upon the soft material, and it was then as good as new on iron or mild steel. Since the file maker is unaware of the purpose of the file he leaves it dead hard, and the experienced always let it down a trifle before putting it into use. When completely discarded the shop smith made quite effective lathe tools, scrapers, screw-drivers, and numerous small tools from the scrap. In fact, in the old days the only source of hard steel easily available was from worn-out

files. Existing scarcity and the need for conservation will, if we are wise, lead us to revive some former practices with advantage.

A sheet of emery cloth should always be broken in before use, otherwise the abrasive will strip at a touch. Pass the back of the sheet backwards and forwards across a convenient square corner in both directions of the sheet. Cloth thus treated will last at least ten times as long The storekeeper should issue half sheets only and himself break them in before issue.

In view of the shortage of textiles, discard waste altogether and use wipers. Most progressive firms have found these more convenient, but from personal observation the minority is still a considerable quantity. The practice of washing in bulk and recovery of grease as a by-product is a real and pressing necessity.

Don't hoard scrap material; sell it as quickly as possible. Prices are tempting, and every small piece of metallic material is urgently needed.

In most shops everyone running a machine tries as a matter of policy to keep as large a quantity of reserve tools as possible, and the ingenuity on the part of the man tends to defeat all attempts on the part of the management to keep the steel stock in active circulation. Whatever can be said from the operator's point of view in normal times, the practice is now indefensible, and—as a point of honor—don't hoard up tools. Discard wherever possible machines not in active commission; they may be of use elsewhere and as scrap they are of national utility. Speed up wherever this is possible; a careful investigation with a speedometer, cut meter, or other testing appliances, may reveal that certain minor machines, especially if in intermittent use, are to some extent neglected. Cut power costs if possible: this can often be done by slight alterations or re-grouping. For ease and by reason of poor organization one often sees large machines doing small jobs. This cannot be always avoided, but the wastage of power in some instances is enormous, and every pound of coal at the moment involves great labor and transport.

Modern Railroad Power Plants.

Recently we took occasion to present some important remarks made by Mr. Basford, president of the Locomotive Feed Water Heating, in regard to the waste of fuel in the older type of locomotives. His convincing proofs showed clearly that the modern locomotive fully equipped with the recently improved fuel-saving appliances pays for itself in a short time, when compared with the meagerly-equipped relics of a bygone period that still hold the place of better equipment Mr. Basford's observations were both timely and pertinent and have already met the warm approval of many of our readers.

In a like spirit William Olson, supervisor of steam plants on the New York Central, takes up the question of waste on the modern railroad power plants, not so much because of poor equipment but more particularly by lack of proper care and maintenance. In speaking before the members of the Central Railway Club last month, he stated that in connection with the economical operation of a power plant, the task is one of eternal vigilance. When the engineer in charge takes up with the foreman questions regarding repairs required, the foreman should at once give them attention, because that will encourage the engineer, and stimulate a desire to keep his plant a little better than that of the other fellow. I have, however, known of some instances where the engineer has been told to wait until they have an opportunity; but I think it is safe to say that the case is rare, where by careful planning ahead, arrangements cannot be made to give the necessary attention and time at once to make small repairs. Taking care of these small repairs in time will surely save costly ones later on.

It has been estimated that 180,000,000 tons of coal are wasted in the United States each year largely in power plants; and the important lessons taught by the Fuel Administration work are: That too little attention has been paid to the proper and economical operation of steam plants as pertains to fuel losses, and I believe the Fuel Administration holds that whipping the Germans will not be a reasonably good excuse for going back where we were before the war, in the way of fuel waste. Wasting coal is not a personal matter, because it is wasting the national resources, and therefore fuel conservation is at all times of great importance.

In all the preventable losses in the boiler room, the human element plays an important part. The first step toward saving coal is to find out with sufficient accuracy, whether there is anything wrong or not, and then locate it, and have repairs made at once. In many cases cracks in furnace walls, air leaks around the clean-out doors, holes around the blow-off pipes, soot accumulations on the tubes and furnace sheets, and a number of other details, are allowed to go on from day to day. The stack damper is often left wide open, without any attempt at regulation.

Boiler settings are designed to hold the heat, which transform the water in the boiler into steam. The temperature inside of this setting runs all the way from 1,500 to 2,000 degrees Fahrenheit. The average temperature in the boiler room is, say, 80 degrees. Now, then, the draft that is pulling the gases up the stack, is also pulling this 80 degree air through the cracks in the settings, which chills the hot gases and the result is that you are burning that much more coal to heat the excess air taken in; therefore, it is of importance for the engineer to continually keep a lokout for the appearance of leaks in boiler setting. The engineer should try out his boiler settings at every opportunity by going around with a torch. This kind of repairs can easily be taken care of by the engineer in charge.

The baffle brick also require close inspection. If the boilers are horizontally baffled the engineer can make his own repairs. If they are vertically baffled the engineer should know whether the gases are short circuited, and if so he should at once make a report to the foreman, who in turn should take it up through proper channels to have repairs made before the boiler is again fired up. If the baffle brick are kept in good condition it will mean the saving of many tons of coal, and relieve the fireman of much unnecessary work.

The following offers a fair guide. Steam at 60 pounds pressure will waste through a square inch leak, 3,918 pounds per hour, or at 30c. per thousand pounds, $846.00 per month. At 150 pounds gauge pressure steam will waste through a leak one inch square, 8,787 pounds per hour, or $1,898.00 per month, at 30c. per thousand pounds. From this it will be seen how important it is to look after the steam leaks. The individuals in the shops or engine houses should be expected to do their part by preventing unnecessary lighting, keeping doors and windows shut, when not needed and in any way by which heat and power may be saved.

There has not been enough attention given to the value of exhaust steam for heating; taking the average non-condensing engine it is safe to say that about 80 per cent of the heat in the steam supplied at the throttle is available for heating purposes in the exhaust steam. In connection with steam heating, there should be a good return system and a good vacuum pump on the other end of a heating system. In large shops use should be made of the exhaust available from steam hammers.

Coupler and Draft Sill Repairs.

The complaint is sometimes and often bitterly made, in these later days, that there is a much more rapid deterioration of railway rolling stock than there was a few years ago. Frequently, perhaps, too frequently, the cause is laid to defective material, but usually someone calls attention to the greater service, and, incidentally the severer stresses to which the present-day car is subjected. It is,

of course, the freight car that comes in for the greater part of the solicitude and anxiety, and there can be no doubt that the damages inflicted upon it are very much greater than they were a few years ago, a statement that will be substantiated by an examination of the repair records of any railway.

One master car builder attributes this to four fundamental causes: the rapid introduction of heavy locomotives, the promotion of large numbers of firemen inexperienced in locomotive handling to the position of engineers, the use of heavier and stronger cars interspersed through a train of weaker and lighter ones, and the work of handling a dense traffic in heavy trains on a single track, where much sawing to and fro has to be done at passing sidings.

Any one of these causes would have an appreciable effect on car repairs, especially in such matters as broken drawbars and sills, but when they are all combined the cumulative result is one at which railway officers may well stand aghast.

Take the single item, perhaps as large as any, of couplers broken or pulled out. Ten years ago this was not such a serious proposition as it is today. At that time on an ordinary road where the car mileage would run from 6,000,000 to 8,000,000 a month the number of broken couplers would range from 25 to 100 in the same time. But these records show a sudden and substantial rise about six years ago, when locomotive weights took a leap ahead and traffic demands required the promotion of large numbers of men. So that now the repair sheets show from two to five times the number of broken or pulled out couplers. It would hardly be possible that any one of the four reasons given could be responsible for the whole increase, but each has contributed its quota to swell the figures to their present formidable proportions.

Strange to say, the number of wheels used has, apparently, not been appreciably influenced by the causes that have had such a disastrous effect on couplers and sills. Records of some of the northern roads show that the number of wheels replaced has increased, on the average, in about the same ratio as the wheel mileage, with a regular annual spasmodic increase for the later winter months of February and March, the first as furnishing a hard and unyielding roadbed and the other one that is heaving and twisting as it is freed from frost. This indicates that the cast-iron wheel is, at least, holding its own in the fight against the greater stresses to which it is subjected. But it will be noticed that not one of the four causes of destruction cited that have such serious effects upon couplers and sills have any effect whatever upon the wheels, with the single exception, perhaps, of the promotion of inexperienced men, and then only as they are affected by the application of the brakes.

Now, what are the possibilities of decreasing this chronic destructiveness?

It is probable that the records of car equipment on most roads will show a gradual elimination of the old cars of 20 tons capacity, so that now they have almost entirely disappeared. As for the 30-ton capacity cars, their numbers are too great to expect their immediate disappearance, but in some places, when the center sills on the old cars are broken they are replaced by steel sills with the couplers and draft rigging attached as substantially as in all-steel cars, so that the practical elimination of the factor of weakness as indicated by use of strong and heavy cars in a train of light ones will disappear as a contributing element of destructiveness long before the 30-ton car will have itself ceased to figure on the equipment roll, if, indeed, that time ever comes. Though, with the introduction of the heavier capacity cars the actual number of 30-ton cars is decidedly on the decrease on some roads.

As for the 40-ton and 50-ton cars, their increase has been and still continues. Some roads are maintaining a nearly constant quantity of the one, while all new equipment is of the other. In these cars the weakness of the wooden underframing has disappeared and steel has taken its place either for the underframing alone or for the whole structure of the car. When this steel construction has taken the place of the old wooden construction to such an extent that it can be regarded as universal, then the third of the four elements will be done away with.

As to whether the car can be made strong enough to withstand the normal stresses applied by the continually increasing locomotive power is a quest on that will undoubtedly be answered in the affirmative. It may involve the construction of a heavier car, but the strength to resist ordinary traction stresses will be found in the future as it has been in the past. And experience and discipline, it is to be hoped, will make the engineer more careful in the handling of the train.

While the last item can probably never be entirely blotted out on a single-track line where stops and starts at passing sidings must be frequent, it can and will be greatly modified in its effects by the use of longer sidings and obviating much of the work that must now be done.

When the general run of rolling stock has been adapted to the new conditions, the freight-car repair bill will be reduced.

Dunkirk Accident.

On July 1 there was a rear-end collision on the New York Central Lines at Dunkirk, N. Y., that resulted in the death of twelve people and the injury of a number of others. The report of the collision is to the effect that a passenger train had been standing in the station for about three-quarters of an hour, and that it was protected by a home block signal 2,000 feet back and a distance signal 4,125 feet back of that, while a flagman with a red light was 1,700 feet back of the train. The speed was estimated at from 40 to 50 miles an hour at the moment of impact.

That the engineer applied his brakes and found that they would not hold is evidenced by his own statement before he died, the fact that he had repeatedly whistled for brakes after passing the distant signal and the finding of the angle cock between the tender and first car closed after the accident.

This, of course, explains the reason for the brake failure. And the angle cock was probably closed by a trespasser who was riding between the tender and the first car, and who was killed. He was identified as a Dunkirk man, and probably closed the angle cock thinking that, in that way, he would be able to stop the train. In this he failed, and the closed angle cock has added another to the list of horrors for which it is responsible. The accident was due to a brake failure, but a failure under circumstances in which the brake is not supposed to act, but it would be well if such a study were to be made of the situation that the closing of the angle cock along the length of the train should have the same effect as the opening of it at the rear; that is, produce an application of the brakes. That this desirable thing can be done there seems to be no doubt, and it is a matter worthy of consideration, so that the accidentally or purposely closed angle cock be robbed of its terrors.

Book Reviews.

ABRASIVES AND ABRASIVE WHEELS. Their Nature, Manufacture and Use, by Fred B. Jacobs. Norman W. Henley Publishing Co., New York. 340 octavo pages, 200 engravings, cloth. Price, $3.00.

The author of this book has taken much pains to collect a mass of authentic data on abrasives and their uses, a subject hitherto hardly available in compact form. The data is very clearly set forth. The work opens with a description of natural abrasive substances, followed by a comprehensive analysis of artificial abrasives, and their manufacture into grinding wheels. Laboratory tests are described, and suggestions submitted for the most economic methods of using grinding wheels. The book is divided into 21 chapters, and it seems to us that every phase of the subject is carefully and fully treated with the result that the mass of information cannot fail to be highly appreciated by the mechanical engineer, the man in the shop or factory, or the student in engineering. The paper, press work and illustrations are up to the usual standard of the enterprising publishing house.

Air Brake Department

Questions and Answers

Locomotive Air Brake Inspection.

(*Continued from page* 211, *July,* 1919)

842. Q.—What prevents a back flow from the main reservoir during an application of the brake?

A.—The brake pipe feed valve, being adjusted to deliver but 10 lbs. pressure.

843. Q.—Is there any less weight on the driving wheels at such times as when engines are dead or without fire?

A.—Yes, there is usually no water in the boiler.

844. Q.—What positions should the brake valve handles be in at such times?

A.—They should be clamped in running position by means of special parts made for this purpose.

845. Q.—What would result if the brake valve handles were moved away from their running position?

A.—If either one was moved away from running position, the brake would fail to release after an application of the brakes, and slid flat wheels would likely result.

846. Q.—What is the difference in the flow of air through a brake valve and feed valve of the ET equipment as compared with that of the G6 brake valve arrangement?

A.—With the ET equipment the compressed air from the main reservoir passes through the feed valve before it reaches the brake valve when the handle is in running or holding position.

847. Q.—With the brake valve handle on lap position, what three principal pressures are separated by the rotary valve of the brake valve?

A.—Main reservoir, brake pipe and and equalizing reservoir pressures.

848. Q.—Where is the actual dividing line between the brake pipe and equalizing reservoir pressures with the brake valve on lap position?

A.—At the equalizing piston packing ring.

849. Q.—Is it possible to have any other than these three pressures in the brake valve ports?

A.—Yes; after certain operations, application cylinder pressure, and what may be termed release-pipe pressure is present in some of the brake valve ports.

850. Q.—What is brake pipe pressure used for?

A.—For operating the equalizing portion of the distributing valve and the car brake operating valves in a train.

851. Q.—What is equalizing reservoir pressure used for?

A.—For operating the equalizing discharge valve of the brake valve.

852. Q.—What is the equalizing reservoir actually used for?

A.—Merely to enlarge the volume in the chamber above the equalizing piston of the brake valve.

853. Q.—What is the automatic brake valve used for?

A.—To control a flow of air to and from the brake pipe, and to act as a retaining valve for the distributing valve under certain conditions.

854. Q.—What is the duty of the equalizing piston of the brake valve?

A.—To mechanically measure the volume of air discharged from the brake pipe.

855. Q.—What is the duty of the feed valve?

A.—To maintain a predetermined pressure in the brake pipe, at a constant figure.

856. Q.—What is the reducing valve used for?

A.—To maintain a pressure for the operation of the independent brake, and the train signal system.

857. Q.—What is the purpose of the distributing valve?

A.—To control a flow of air from the main reservoir to the brake cylinders in applying the brake, and from the brake cylinders to the atmosphere for releasing the brakes and to maintain the brake cylinder pressure against leakage.

858. Q.—What is the purpose of the signal line non-return check valve?

A.—To prevent a back flow of air from the signal pipes when the independent brake is applied.

859. Q.—What would a back flow result in?

A.—An undesired blast of the signal whistle.

860. Q.—What governs the rate of flow to the signal system?

A.—The signal line choke fitting.

861. Q.—Why does a back flow of air occur if the independent brake is applied and the signal line non-return check leaks?

A.—Because of the momentary drop in pressure in the reducing valve pipe, when this air pressure is admitted to the application cylinder of the distributing valve.

862. Q.—What is this drop in pressure principally due to?

A.—The small volume of the reducing valve pipe, and the time required for the reducing valve to open and supply the drop in pressure.

863. Q.—Is this drop in pressure positive to occur?

A.—Yes, under ordinary circumstances.

864. Q.—Why?

A.—Because there must be a drop in the reducing valve pipe pressure before the reducing valve can operate.

865. Q.—How is the dead engine fixture used?

A.—A stopcock in the pipe leading to it is opened, which admits brake-pipe pressure to the main reservoir of a dead engine.

866. Q.—Why is main reservoir pressure necessary on a dead engine?

A.—For the operation of the engine and tender brakes.

867. Q.—How is the rest of the equipment then arranged?

A.—The stopcock under the brake valve is closed, the handles are to remain in running position and the adjusting nut of the safety valve is to be slacked off.

868. Q. — How many necessary branches are there from the main brake pipe on a locomotive?

A.—Three.

869. Q.—Where do they lead to?

A.—To the automatic brake valve and to the distributing valve, and to the small, or number 2, air gauge.

870. Q.—What is the name of the pipe leading to the small air gage?

A.—The brake pipe gage pipe.

871. Q.—What is the other pipe connecting this gage called?

A.—Brake cylinder gage pipe.

872. Q.—What is the name of the pipe connecting the main reservoir and maximum pressure top of the governor?

A.—The governor pipe.

873. Q.—What pipe leads to the upper connection of the excess pressure governor top?

A.—The excess pressure pipe.

874. Q.—What is the lower pipe called?

A.—The excess pressure operating pipe.

875. Q.—What is the difference between the SF and SG types of governors?

A.—With the SG type there is no excess pressure operating pipe, or rather the operating and governor pipes are combined.

876. Q.—What does this eliminate?

A.—A pipe leading from the brake valve to the excess pressure top.

877. Q.—What is gained by this?

A.—There are no features added, but the operating pipe port in the brake valve becoming stopped up does not interfere with the operation of the SG governor.

878. Q.—Can the SF be converted to the SG type?

A.—If desired a branch from the governor pipe can be connected to the operating pipe connection, or a special manifold fitting may be obtained for the purpose.

879 Q.—Is there any difference in the operation of these governors?

A.—None whatever.

880. Q.—How can the excess pressure portion operate, or be made inoperative when the brake valve handle is moved to lap, service or emergency position, when the brake valve movement will not cut the main reservoir pressure away from below the diaphragms of the excess pressure portion?

A.—A port in the rotary valve registers with one in the seat that admits main reservoir pressure to the feed valve pipe and to the top of the diphragms in all H6 brake valves, so that it is not absolutely necessary to have the pressure below the diaphragms cut off in order to render this top inoperative.

881. Q.—What kind of repairs should be made to a governor if reported defective?

A.—The nature of the defect should first be ascertained, and if in the steam portion the entire governor should be removed from the engine for repairs.

882. Q.—Repairs on the locomotive or in the engine house should be limited to what?

A.—To cleaning the diaphragm portion and knowing that the operating pipe is open.

(To be continued.)

Train Handling.

(Continued from page 212, July, 1919.)

895. Q.—Could the independent brake then be used?

A.—No.

896. Q.—Could the automatic?

A.—Yes.

897. Q.—What should be remembered in such cases?

A.—That the brake could not be released with the independent valve if the driving wheels were to pick up and slide.

898. Q.—Could temporary repairs be made to a broken application cylinder pipe without resorting to plugging?

A.—Yes; the release pipe could be connected at the application cylinder connection.

899. Q.—Could this be done with the modified distributing valve where the release pipe branch between the brake valves is usually disconnected?

A.—Yes; the independent valve could then be placed on lap position.

900. Q.—What would be done in the event of a broken release pipe?

A.—Nothing whatever.

901. Q.—What would be lost?

A.—The holding feature of the automatic brake and slow application and lap positions of the independent brake valve.

902. Q.—Would the operation of the automatic brake be affected in any other way?

A.—No.

903. Q.—Could the brake still be released with the independent valve?

A.—Yes.

904. Q.—What could be done in the event of a broken release pipe in yard shifting service, and it was desired to use the independent brake.

A.—The opening toward the distributing valve would be plugged.

905. Q.—How would the independent valve handle be kept in release position in order to keep the application cylinder open to the atmosphere?

A.—The return spring casing screw in the independent valve body could be removed.

906. Q.—And this would accomplish what?

A.—Release the return spring so that the handle would remain in release position.

907. Q.—Why would this be desirable?

A.—It would not be necessary to hold the valve handle in release position until the brake has completely released, and the brake would not reapply from slight leakage into the application cylinder, or undesired movements of the equalizing portion of the distributing valve.

908. Q.—What could be done in the event of the brake pipe branch to the automatic brake valve breaking off?

A.—There are several ways in which connections could be made to operate the brake, after a certain fashion.

909. Q.—What is the first consideration?

A.—To get air from the main reservoir into the brake pipe of the cars in the train.

910. Q.—What is about the quickest way in which this could be done?

A.—By coupling the brake cylinder hose at the rear of the engine with the brake pipe hose at the front of the tender.

911. Q.—In this case what would be done as the pipe broke off?

A.—The automatic brake valve handle would be left on lap position, the engine and tender brake would be released with the independent brake valve and the stop cocks in the brake cylinder pipe leading to the cylinders on the engine closed, then the connection would be made between the engine brake cylinder hose and the tender brake pipe hose.

912. Q.—How would main reservoir pressure then enter the brake pipe of the cars?

A.—The independent brake valve would be moved to slow application position moving the application position of the distributing valve to application position admitting air from the supply pipe to the brake cylinder pipe, but instead of into the brake cylinders, to the brake pipe of the cars.

913. Q.—This would give but 45 lbs. brake pipe pressure?

A.—Screwing up on the adjusting nut of the reducing valve would give any pressure desired.

914. Q.—Would not the safety valve of the distributing valve open and discharge pressure when 68 lbs. brake pipe pressure was obtained?

A.—Yes, but the adjusting nut can be screwed down to prevent any discharge from the safety valve.

915. Q.—After the brake system of the cars have been charged to the required pressure and the brakes have released, how would the brakes be applied?

A.—By moving the independent brake valve handle to release position.

916. Q.—And this would exhaust pressure from where?

A.—The brake cylinder pipe of the engine and the brake pipe of the cars.

917. Q.—Through what sized opening would brake pipe pressure be discharging?

A.—Through a 5/16 in. opening.

918. Q.—Located at what point?

A.—In the angle fitting of the brake cylinder hose connection at the rear of the engine.

919. Q.—Would there be a brake on the engine or tender?

A.—No, the stop cocks leading to the engine brake cylinders are closed, and the brake cylinder hose of the tender is disconnected.

920. Q.—What should be remembered in a case of this kind?

A.—That it is quite likely that the brakes could not be applied in quick action on account of the choke in the fitting referred to.

921. Q.—Do all engines have this choked fitting?

A.—No, through renewals or while engines are shopped the fittings sometimes disappear, although they are standard and furnished with the ET and LT equipments.

922. Q.—What could be done if it was desired to have a brake that would operate in quick action?

A.—The choke fitting could be exchanged for the ordinary angle fitting of the brake cylinder hose on the tender.

923. Q.—What is the object of the fitting?

A.—To prevent a loss of main reservoir pressure if the brake cylinder hose were to become uncoupled between the engine and tender or if one of these hose bursted.

924. Q.—What would be the advantage?

A.—Air from the main reservoir would escape through a 5/16 in. instead of a 3/4 in. opening and the driver base cylin-

der pressure could be maintained against the 5/16 in. opening.

925. Q.—With a broken off brake pipe and the arrangement referred to, what maintains the pressure in the brake pipe of the cars.

A.—The application portion of the distributing valve.

926. Q.—And is it as sensitive as the brake pipe feed valve?

A.—By no means.

927. Q.—What might then be expected in the event of considerable brake pipe leakage?

A.—Occasional cases of stuck brakes.

928. Q.—And to be released in what manner?

A.—As usual by an application of the brakes if necessary.

929 Q.—Could this same method be employed in the case of a broken reservoir pipe near the automatic brake valve, in the event that the feed valve was attached to the brake valve.

A.—Yes.

930. Q.—What kind of a brake is this considered to be?

A.—Merely as an emergency brake, used to get the train to some point at which proper repairs can be made.

931. Q.—Is there any other way in which the brake pipe could be charged if the brake pipe is broken off at the automatic brake valve or the reservoir pipe near the same point?

A.—Yes, and it might be preferable for a short train.

932. Q.—How is it done?

A.—By removing the equalizing piston and slide valve from the distributing valve and replacing the cylinder cap then closing the stop cock in the distributing valve supply pipe.

933. Q.—Where and how would air pressure flow to the brake pipe?

A.—Through the independent brake valve, the equalizing portion of the distributing valve.

934. Q.—And the independent valve handle would be carried where?

A.—In quick application position.

935. Q.—How kept there?

A.—By removing the return spring casing screw.

936. Q. — Under the circumstances where would the automatic brake valve handle be carried?

A.—The brake valve handle should be carried either on lap position or running position, depending upon where the brake pipe was broken.

(To be continued.)

Car Brake Inspection.

(Continued from page 213, July, 1919.)

835. Q.—How is the safety valve adjusted?

A.—By means of an adjusting nut which can be reached after removing the cap nut.

836. Q.—When properly adjusted what figure does it open at?

A.—At 62 lbs.

837. Q.—And closes at what point?

A.—At not below 58 lbs.

838. Q.—How is this opening and closing point regulated?

A.—By means of the adjusting rings encircling the body of the valve.

839. Q.—Which is the ring that governs the operation?

A.—The lower ring.

840. Q.—What is the upper one for?

A.—A lock ring for the lower one.

841. Q.—How does the lower ring control the range of pressure governed by the valve?

A.—By increasing or decreasing the openings from the adjusting spring chamber to the atmosphere.

842. Q.—How is the final test made with the safety valve?

A.—With the cap nut securely tightened?

843. Q.—Why is this necessary?

A.—The cap nut forms a stop for the lift of the piston valve and the lift of the valve materially affects the opening and closing of the safety valve or rather the regulation of the brake cylinder pressure.

844. Q.—Is repairing and adjusting these valves a particular operation or one requiring skill?

A.—No, with a little practice anyone can repair and maintain these types of valve.

845. Q.—What can be done if the piston valve becomes too loose a fit in the bushing and will no longer regulate the pressure as required?

A.—The valve should be returned to the manufacturers for repairs.

846. Q.—What can be done if the piston valve seats start a leak?

A.—A suitable tool can be made for grinding the valve to its seat.

847. Q.—What kind of a tool?

A.—A piece of iron with a thread cut to screw into the piston valve.

848. Q.—What is the most important adjustment in connection with a brake equipment?

A. That of the brake cylinder piston travel.

849. Q. Why?

A.—Because its variation varies every operation of the brake so far as the development of braking force is concerned.

850. Q. In what way does it affect the time of brake application?

A. The change in the travel, requiring different volumes to produce the same pressure per square inch, also varies the time required to obtain the braking power in a proportionate degree.

851. Q.—What is the most serious disorder that will be produced by unequal piston travel outside of the unusually long travel that may result in a loss of train control?

A.—It means that several times as much braking power or retarding effect may be obtained on one car than on another, and this difference results in shock and rough handling of trains.

852. Q.—Can the engineer control the slack action in trains that is the result of unequal piston travel?

A.—As a general proposition the engineer has no control whatever of the action of brakes resulting from unequal brake cylinder piston travel.

853. Q.—How does the long piston travel contribute to a loss of train control.

A.—The longer the travel the greater the volume of compressed air that will be required to produce a given brake cylinder pressure, and in handling trains on long descending grade, the drain on the main reservoir through too long travel may be the deciding factor in safety in train control.

854. Q.—Can you tell the three terms that are used to designate piston travel?

A.—Running travel, standing travel and theoretical travel.

855. Q.—What is the theoretical travel?

A.—The distance the brake piston is allowed to move in order to give the proper brake shoe clearance, plus the movement due to the difference in the diameter of the pins and holes of the foundation brake gear.

856. Q.—What does the theoretical travel approximate?

A.—Standing travel.

857. Q.—What does the theoretical travel equal?

A.—The shoe clearance times the total leverage ratio, plus the travel necessary to take up the lost motion through the difference in diameter of the pins and pin holes.

858. Q.—What is the actual travel?

A.—Running travel.

859. Q.—What is the difference between the theoretical travel and the running or actual travel?

A.—The actual travel comprises all of the theoretical travel and in addition that resulting through losses encountered elsewhere in the foundation brake gear and the trucks of the car.

860. Q.—Where is this lost motion usually found to exist?

A.—From loose brasses in journal boxes, play between boxes and pedestals, brake beam deflection, unusual temporary strains or to anything that produces or increases lost motion even to that resulting from drawing trucks close together when the brake is applied with the car in motion. (Assuming that the brake cylinder operates the brakes on both trucks.)

861. Q.—How is this difference between running and standing travel materially affected by the hanging of the brake beams?

A.—If hung from the car body or from the truck frame above the springs, the piston travel will be unduly lengthened as the pull of the shoes on the wheel tends to draw the shoe nearer to the rail thus shortening the distance between the brake beams and increasing the piston travel.

862. Q.—What is the difference when the car is loaded?

A.—This action is intensified, that is, the piston travel is increased to a much greater degree.

863. Q.—What determines the amount of pressure that will be obtained in the brake cylinder for a given brake pipe reduction?

A.—The ratio between the brake cylinder and auxiliary reservoir volumes.

864. Q.—Where is this variation, the auxiliary reservoir being of a fixed size?

A.—In the brake cylinder, the volume varying with the change in piston travel.

865. Q.—For a 10-lb. drop in pressure in the auxiliary reservoir, what then governs the brake cylinder pressure that will result?

A.—The brake cylinder piston travel.

866. Q.—About what brake cylinder pressure should be obtained from a 5-lb. brake pipe reduction, with 7½-in. or 8-in. piston travel.

A.—About 5 lbs. or a trifle more.

867. Q.—How much if a 10-lb. brake pipe reduction is made?

A.—About 23 lbs.

868. Q.—Why the vast difference between the two 5-lb. reductions?

A.—The auxiliary reservoir pressure that was expanded during the first 5 lbs. reduction was subjected to some losses that the second 5 lbs. was not, but the main loss was through filling the brake cylinder to atmospheric pressure before any gage pressure could be developed.

869. Q.—Or in other words?

A.—If the brake cylinder piston had been drawn out by some other force than the entrance of the compressed air, and the triple valve exhaust port had been closed, the cylinder would have contained a partial vacuum, and 14.7 lbs. pressure per square inch would have been required to first fill the cylinder space vacated by the piston before any gage pressure could have registered.

870. Q.—The first 5 lbs. from the auxiliary reservoir then does what?

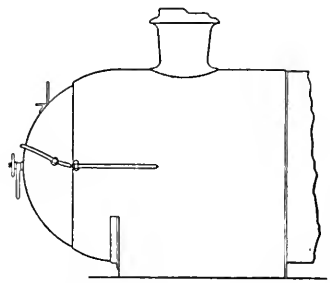
A.—Fills the space vacated by the piston to atmospheric pressure, with the result that a very low gage pressure is obtained, but for the second 5 lbs. which is not subjected to such a loss, the total of the two 5-lb. reductions results in a considerable gage pressure, or approximately one-half of the maximum attainable for a full service brake application from a 70-lb. brake pipe pressure.

(To be continued.)

Wind Resistances

Our readers are familiar with the more or less spasmodic attempts that have been made to lessen wind resistance to train movement. Conical projections have been put upon smokeboxes, the fronts of domes, stacks, and cabs have been made wedge-shaped and cars have been smoothed off on the sides. None of these devices, however, have come into general use, probably because their advantages were not sufficient to pay for the expense of application.

There are very few fundamental principles among natural laws, and there is little reason why there should be a great difference between air and water resistances. In the water fast-swimming fishes are rather blunt at the head, with a long taper to the tail, and our cup-winning yachts have the same peculiarity of having the greatest breadth of beam well forward, with a long, easy run aft. And now come the builders of aeroplanes and dirigibles, who have shown that in order to secure the best shape for bodies that are to be driven through the air at high speeds the front should be quite "bluff," a sharply conical or wedge-shaped form not being at all the ideal to be aimed at. This matter has been handled at some length by a writer in The Engineer, who shows that what is required in order to reduce air resistance is to cut down the transverse flat surface as much as possible, smooth off projections and use gentle curves parallel to the natural flow of the air.



PROPOSED DESIGN OF LOCOMOTIVE FRONT TO LESSEN WIND RESISTANCE.

The horsepower needed to overcome front wind pressure increases with the cube, not merely of the speed of the train, but also with that of what is called the "created wind," which in the case of express trains may easily exceed 80 m.p.h.

He calls attention to the fact that the smokebox of a locomotive lends itself very well to modifications in this direction and suggests that by forming the door with a radius of something under 3 ft., instead of the usual one, which is frequently as much as 18 ft., we can produce a front door much superior from an aeronautical point of view, such, for example, as that shown in the illustration. It is reasonable to expect this smokebox to effect a saving of the order of 25 hp. when the "created wind" speed is 60 m.p.h. and 60 hp. when it is 80 m.p.h.

The author claims that the shape of the locomotive is deserving of careful study and that some modifications of such value as not only to be worth making in the case of new engines, but possibly even worth while to be introduced in the existing ones as they come into the shops for heavy repairs.

Certainly there is no good reason to think that the principle of air resistance to a locomotive is different from its resistance to any other body, and if train resistance is to be cut down, the methods similar to those adopted for aeroplanes and balloons should be adopted.

New Salvador Railroad.

The construction of a railroad line from Santa Ana, Salvador, the northern terminus of the Salvador R. R., to Zacapa, Guatemala, which is on the Guatemalan Transcontinental, Central America, has attracted the interest of American capital. Its first function is to give Salvador, the most thickly populated country on the Western Hemisphere, as it is the smallest, an outlet on the Caribbean. At present, on account of the lack of railway connections, Salvador has to be approached from New York through the Panama canal. The secondary point of interest in connection with the new road is the fact that it is one additional link in the projected Pan-American route.

Administration Bulletin.

The Railroad Administration is now publishing the United States Railroad Administration Bulletin to be circulated free to employes on all railroads under Federal control that do not have employe's magazines of their own. The bulletin is issued monthly and the first issue contains eight pages, largely devoted to news of the activities of the Railroad Administration, but including two pages of local matter contributed by 85 local editors on the various railroads. The circulation is 1,000,000 copies a month and the bulletin is printed in six different cities in 85 editions, one for each railroad or group of railroads, each containing the articles prepared in Washington and the distinct local matter. Thomas H. MacRae, formerly managing editor of the *Santa Fe Employes' Magazine*, is editor in chief of the publication.

Electrical Department

The Recovery of Valuable Material from Smoke and Gases by Means of Electricity—Electrical Precipitation.

Electricity has done and is doing many wonderful things. It has been used extensively to perform many duties. One of its most recent applications is that to the electrical precipitation, and an application of which generally little is known.

The dust and fumes which are discharged from the stacks of iron furnaces, cement mills, copper smelting furnaces, etc., represent a waste of valuable material. Moreover they also frequently constitute a nuisance. There are several mechanical and chemical methods for collecting this loss, but they are in general limited. Temperature, acidity, etc., affect them. The electrical precipitation process has very few limitations and can be generally applied for collecting suspended solid and liquid particles of every description, whether acid or alkaline, and from gases of widely varying temperature.

The electrical process has been used successfully in lead smelters and copper smelters, to collect the metal from the stacks and to eliminate smoke nuisances; in cement plants to collect potash and cement dust; in acid plants to recover acid fumes; also in rock crushers to suppress the dust; in iron blast furnaces to eliminate the ore dust and to recover potash; in gas plants to remove dust, tar and lampblack, and in various other industrial processes. In general the process applies to the collecting of suspended solids and liquids carried in gases.

The effect of the electrical precipitation is very noticeable. With no electric current connected to the "treater," the familiar smoke clouds can be seen coming from the stack, but with the current "on" the smoke has vanished and just the trace of a vapor can be seen. The final proof of the effectiveness is the carloads of dust taken from the collecting bins

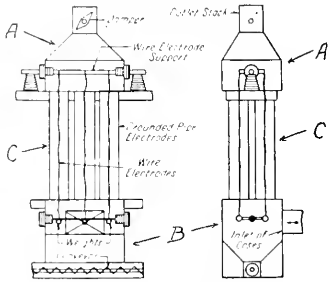


FIG. 2. SCHEMATIC DIAGRAM OF ELECTRICAL PRECIPITATION PIPE TREATER

Before describing the process and the apparatus more in detail, two examples of what can be obtained by the installation of this apparatus are given. These examples give some idea of the economies to be gained, and the great waste of materials and what it means to some large plants.

A copper smelting company installed an electrical precipitation equipment at a cost of approximately $115,000. The operating expenses for the power, labor, etc. amounted to approximately $15,000 a year, making a total cost for the first year of $130,000. Here is the interesting part—the value of the copper dust collected for the first year, the dust being worth 12c a pound, was approximately $180,000. The savings for the first year amounted to more than the total cost and labor. In the succeeding years a very magnificent profit resulted.

Another example is that of a cement plant. The equipment cost approximately $180,000; labor for the year of approximately $11,000; the value of the cement dust and potash secured amounted to approximately $80,000, a very satisfactory profit.

While these examples are for large plants, smaller plants can be equipped at nearly proportional cost and with proportionate recoveries.

Let us see what are the principles of electrical precipitation. The "Treater" is of a simple structure and in general consists of two large horizontal flues "A" and "B" (Fig. 1) connected together by a number of small vertical pipes "C." The stack gases enter one flue (in this case the lower flue B), passes up through the pipes "C" to the other flue, where they are discharged into the stack. In each of the vertical pipes is suspended a small wire or a small chain, carefully insulated from the pipe which is grounded. Each wire is charged to a high potential or voltage usually at from 25,000 to 65,000 volts direct current. Here is a condition of a wire charged with a very high voltage and surrounded by a pipe which is grounded. There is therefore in each pipe an intense electrostatic field. The chimney gases press through this intensive field and become what is known as ionized. That is, each ion coming in contact with the wire or chain becomes charged with electricity. These highly charged ions are continually colliding with the suspended solid and liquid particles in the gas and impart a charge of like potential to such particles. The ions travel at right angles to the wire and the charged particles begin to travel towards the opposite electrode or, in this case, towards the side of the pipes. The gases receive a static charge of the same polarity as the wire and the particles are projected against the inner surface of the pipes, where they tend to stick and accumulate until the electric current is turned off. The dust is collected by rapping the sides of the pipes. Hoppers at the bottom carry it off.

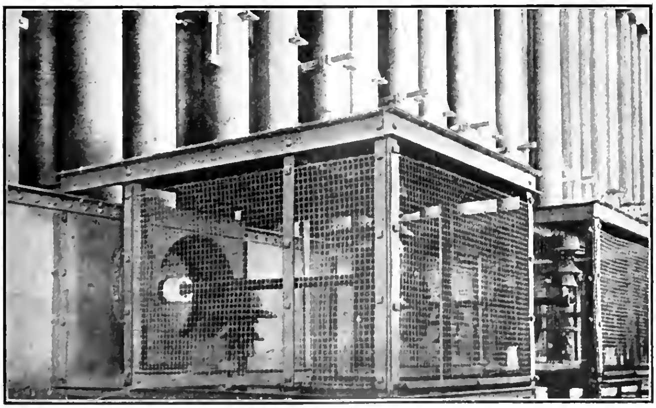


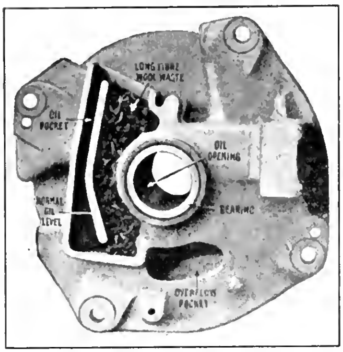
FIG. 1. TREATER FLUES SHOWING PROVISION FOR RAPPING TUBES AND INSULATED SUPPORTS FOR ELECTRODES

Lubrication of Railway Motor Bearings.

To insure a cool running bearing it is important that a steady supply of lubricant be constantly fed into it. The source of supply must be a part of the motor and of sufficient supply to last between inspection periods. There are several different general methods of lubrication which have been used, as follows:

1. *Grease.*—A heavy grease is stored in a box or cup over the bearing. As heat is developed by the friction of the bearing the grease melts and runs into the shaft.

2. *Grease and Oil.*—The same arrangement for the grease is used, but in addition an oil well is located under the bearing and the oil is fed to the shaft by a wick.



SECTION THROUGH ARMATURE HOUSING.

3. *Oil and Rings.*—Oil is located directly under the bearing in which a small brass ring runs. The ring is suspended on the shaft and with rotation of the shaft the ring rotates. The lower part of the ring passing through the oil carries the oil up to the bearing.

4. *Oil and Waste.*—Oil is placed below and to one side of the bearing. Saturated waste is packed into the bearing housing so that it presses against the bearing through a window cut in the bearing shell. The oil is absorbed by the waste as used by the bearing.

5. *Vaseline Packed.*—The entire bearing is packed in vaseline. This method is not adapted to the ordinary sleeve type bearing. It is used mostly in the case of the anti-friction bearings, namely, ball and roller.

6. *Circulating Oil.*—Oil is forced through the bearing by means of an oil pump.

Method 4 is that used in the modern railway motor and let us consider it more in detail. With oil and waste lubrication a good grade of mineral oil should be used. Generally two grades are used, a light oil called "winter oil," and for winter use where cold weather exists, and a heavy oil called "summer oil," for use in the summer or where cold or freezing weather does not exist. The waste should be a long-fiber wool waste and before using it should be saturated in oil for at least 24 hours and left on a grating or screen to drain. The motor housing, carrying or holding the bearing, should be designed with an oil well having ample capacity to hold sufficient oil to last for a few thousand miles; it should have an accessible opening for refilling. The saturated waste should be loosely packed in the chamber and forced into place by a rod or packing hook. The waste, being springy, will hold itself up against the journal.

A good designed bearing if properly packed, should run from one to three weeks. The amount of oil used will depend somewhat on the service conditions and varies with the size of the motor and the size of the bearing. Too much oil can not be added at one time.

The Swiss Railways Extend Electrification of Their Lines.

The introduction of electric traction on the lines of the Swiss Federal Railways has in these latter years, on account of the acute shortage of coal occasioned by the war, received the foremost attention of the authorities and has now emerged as a very practical economic question.

The principal nerve of the Swiss railway system is Government owned. The electrification of these lines is simplified by the vast store of unused water power which the country possesses. According to an official survey, verified in 1914, including the stowing and improvement of lakes, the water power of Switzerland is capable of producing an energy equal to 2,173,000 horsepower. If old plants were replaced by new ones it is even estimated that the highest efficiency of the total water power reserves could be raised to as much as 8,000,000 horsepower. On January 1, 1914, the electric power already in use in Switzerland amounted to 887,000 horsepower.

The Swiss Confederation owns some 1,800 miles of the entire railway system of the country which covers 3,216 miles. Of the 1,416 miles owned by private companies 622 miles are already electrical, but only an insignificant percentage of the Government railroads has so far been operated by electricity.

The first important Federal standard-gauge road to be chosen for electrification was the Gothard Railway, one of the important international highways, featuring moreover in many sections the brilliantly conceived engineering of mountain railways. The electrification of the 68 miles section Erstfeld-Bellinzona was approved in 1913, and it is expected that it will be opened this Fall. This section, with 28 per cent. of its length consisting of tunnels and a grade of 2.5 to 2.7 per cent. for 25 miles, was chosen for an experiment because of its enormous traffic with Italy. The operation of steam locomotives and the large consumption of coal resulting therefrom caused much smoke in the tunnels.

The sections Bellinzona-Chiasso and Erstfeld-Lucerne are expected to follow in 1921 and the consulting experts have found that the big power stations at Amsteg and Ritom, the first yielding 26,000 horsepower and the latter 32,000 horsepower, will also suffice for these lines, even if the traffic should increase some 60-70 per cent. Another series of plants yielding 70,000 horsepower is planned for eastern and central Switzerland.

The cost of electrification of the Erstfeld-Bellinzona line is estimated at $8,000,000. The cost of electrifying the entire Federal railway system is estimated roughly at $200,000,000.

In 1918 the electrification of the following railways using steam traction was decided upon and work on them commenced at once: the sections of the Federal Railroads Sion-Brigue and Berne-Thun; the section Hasle-Langnau of the Emmenthal Railroad and the section Bevers-Filisur of the Rhaetian Railroads.

The to be electrified section Sion-Brigue will be a continuation of the electric traction Simplon tunnel which was opened for traffic in 1906, with its northern exit at Brigue.

The electrified Berne-Thun line, connecting with the electric Berne-Lötschberg-Simplon railway, which latter was inaugurated in 1913, has already been opened for traffic in May last. It now provides excellent and frequent train connections between the Swiss Capital, the Bernese Oberland resorts and—in connection with the Lötschberg line—the Valais and Northern Italy.

The new locomotives which are being used by the Swiss Federal Railroads on the section Berne-Thun, besides those of the Berne-Lötschberg-Simplon line, are each equipped with four single phase-alternate current motors, each of 450 horsepower. The electric parts were furnished by Brown-Boveri & Company, Baden, and the mechanical parts by the Swiss Locomotive and Machine Company of Winterthur.

The electrification works on the Bevers-Filisur line were completed by middle of last April and from April 16 steam engines have been duly replaced by electric motors, the current being supplied by the Power Station of Bevers, which furnishes the necessary energy for the Engadine lines which were electrified in 1913.

Coke.

Furnace coke is used for heating purposes in so many metallurgical processes and is also used for firing locomotives where there are stringent regulations against smoke production that it is of interest to all railroad men. For long runs, however, coke has not proven itself to be altogether satisfactory for locomotive work, owing to the volitilization of the ash and its subsequent freezing on and choking of the back tubesheet.

The old-fashioned beehive oven, in which the great bulk of the coke made in this country was burned, took a charge of about 4½ tons for 48-hour and 5½ tons for 72-hour coke. That is, coke that was burned for 48 and 72 hours, respectively, before pulling. The ovens are subjected to a rather strenuous treatment. When they were opened the whole mass of coke is incandescent and is extinguished by turning a stream of water onto the mass with a hose, so that the brick lining is also subjected to great changes of temperature.

The brick used for liners are of a closely ground fire clay. For the bottoms there is used a mixture of soft and hard fire clay, closely ground and hard burned to stand the wear of the coke. These are made into tiles 12 in. by 12 in. by 1¾ in. Silica brick is used almost exclusively for the crowns, and coarse-ground fire clay for the doorjambs. The trunnel rings are made in one large ring of fire clay or made up of nine silica or clay bricks.

The use of silica brick for the crown of coke ovens is a practice of comparatively recent origin. It was first suggested by Mr. Jared M. B. Reis, of the United States Coal and Coke Co. This was first done about 1901, in the Connellsville region, where the practice was ridiculed as impossible. Even the brick men themselves held this view and claimed that when water was turned into the ovens the silica brick would go all to pieces. At that time there were only a few brick works that had the quality of fire clay necessary for making good coke oven crown brick, but after Mr. Reis' demonstration that silica brick was far superior to any clay brick almost any brick works could obtain the material to make first-class crowns, and the silica brick is now used almost exclusively.

In the Connellsville district, which was for many years the center of the coke-producing industry of the United States, about 66 2-3 per cent of the weight of the coal charged is recovered as coke. These are both actual and theoretical conditions. In the Pocahontas district, owing to the low percentage of volatile matter in the coal, which runs from 16½ to 19 per cent, there is a theoretically possible yield of 80 per cent, but this is not obtained in practice, because considerable coal is wasted in the coking process, and an actual yield of from 55 to 65 per cent would probably represent the yield in the Pocahontas field. The accompanying table gives some of the prominent characteristics of the Connellsville, Banner Seam and Pocahontas coke.

PHYSICAL AND CHEMICAL PROPERTIES OF BEEHIVE OVEN 48-HOUR COKE.

Locality	Pounds in one cubic foot		Percentage by volume		Compressive strength per cubic inch ¼ ultimate strength	Height of furnace charge supported without crushing	Hardness	Specific Gravity	Chemical Analysis					
	Dry	Wet	Coke	Cells					Moisture	Volatile matter	Fixed carbon	Ash	Sulphur	Phosphorus
Connellsville standard coke.....	59.69	90.28	60.47	39.53	301	120	3.0	1.80	0.42	0.80	87.46	11.32	0.69	0.015
Upper Banner Seam Coke...	57.11	86.46	66.67	33.33	260	104	3.0	1.75	....	1.735	87.711	9.660	0.894	...
Lower Banner..	60.96	87.78	60.87	39.13	300	120	3.0	1.75	...	1.886	87.407	10.095	0.612	...
General Average	59.04	87.09	63.77	36.23	280	112	3.0	1.75	...	1.810	87.554	9.877	0.753	...
Pocahontas Coke	59.68	89.64	52.07	47.93	236	94	2.5	...	0.345	0.341	92.694	5.882	0.738	0.0063

It will be seen that as a burden bearer the Connellsville coke and that from the Lower Banner Seam stand first, but for high carbon and low ash content the Pocahontas outranks all of the rest. The table is of value to all foundrymen who are using coke for melting purposes, and, incidentally, the heat value of the product can be obtained from it for locomotive work.

German Destruction of French Locomotive Works.

The Railway *Gazette* (London) remarks the damage done by Germans to the famous locomotive works of the Compagnie Fives-Lille and states on information of Belgian correspondents that equipment to the value of £2,000,000 has been removed or destroyed. One item in this list of destroyed apparatus includes 750 electric motors. The Germans employed highly efficient methods of demolition. For example, they introduced the use of massive blocks of iron as battering rams to demolish the machinery that they had not the opportunity to remove. These blocks they swung by chains from overhead travelling carriages, then drove them against the machinery marked for destruction. An alternative method was to hoist the machines themselves as high as possible, then let them crash down on the cement floor. The invaders sometimes coveted the steel construction sheds in which the equipment was housed. Three of these sheds, for instance, were more than 600 ft. long and 120 ft. wide, and yet the wreckers dismembered these sheds, packed them with care, and sent them on their way toward the Rhine. These facts and figures may serve to give some conception of the vast amount of new equipment that will be needed before the factories in the Lille district can be put on a productive basis again.

Pulverized Coal.

At a meeting of the International Fuel Association it was stated that the use of pulverized coal in a certain test had shown a saving of 23 per cent as compared with hand-fired coal. This sounds a trifle high and it would be well to look into all conditions before accepting them in the present stage of the art, though there is no doubt that notable economies should result, because of the more scientific method of combustion that prevails in the pulverized coal firebox. The matter has gone so far that the experimental stage has about been passed and it is to be hoped that during the next year or so the experiments so auspiciously begun on the New York Central and elsewhere will be carried to their full fruition and the difficulties of pulverization, drying, transportation, slagging of tube sheets be entirely done away with, as there seems to be every probability that such a result can be accomplished.

Railway Men for Russia.

The office of the director general of military railways is desirous of securing the services of a few good roundhouse foremen, and men who have had experience in railway storekeeping, for railroad work in Russia. The machinist and car foremen will be paid $2,000 a year and all expenses, including uniform, etc., and will rank as second lieutenants in the Russian Railway Service Corps. The store material men will be ranked as either first or second lieutenants, receiving $2,500 or $2,000. Applications should be addressed to "Officer Director General Military Railways, 2709 Munitions Building, Washington, D. C., attention Lieutenant R. G. Cole," and should give applicant's experience in detail.

A Standard Caboose.

In the work of attempting to standardize a caboose the administration is trying to devise a 24-foot caboose which will comply with all the complex state laws governing the operation of this class of equipment. Several roads are planning to build as opportunity offers and the standard type will permit interstate operation.

Boiler Water Treatment

A Description of the Various Methods Employed

If you cover a steam pipe with asbestos, magnesia or other heat-insulating material, you keep the heat in the steam; if you line or coat a boiler tube with scale or other heat-insulating material, you keep the heat out of the boiler water and send it to the stack. By lagging your pipes you save fuel easily. By lining your tubes with scale you waste it continuously and needlessly. All natural waters contain more or less of this heat-insulating material, partly as suspended matter (such as clay, fine sand, insoluble forms of iron, aluminum, &c.), partly as dissolved matter, such as compounds of calcium, magnesium, sodium, potassium and other mineral salts. Much of the suspended matter, as well as most of the dissolved matter, may form scale, but the suspended matter may generally be removed by filtration, which will be discussed later.

Of the material commonly in solution in boiler waters, the bicarbonates and sulphates of calcium and magnesium are the most important scale formers. Natural waters containing in solution bicarbonate of calcium or magnesium, or both, exhibit what is called "temporary" or "carbonate" hardness; those containing dissolved calcium or magnesium sulphate, or both, possess "permanent" or "sulphate" hardness. In the case of the sulphate scale the temperature required to separate it is too high to make its removal by heating alone a practical means of treatment. In the case of water exhibiting carbonate or temporary hardness, great improvement in its properties may be effected by the use of open heaters of the exhaust steam type. As a rule sulphate scale is denser in structure with a higher heat-insulating value than carbonate scale, but the conditions of formation affect this considerably. Where a porous structure permits water to penetrate the scale its heat-insulating effect is greatly reduced. In many respects the effect of an increasing deposit of scale on the passage of heat through the walls of a boiler tube is very similar to the effect on the passage of water through a tube of continually decreasing bore. In the case of the water tube, the only way to get a uniform volume of water through it in a given time, in spite of its diminishing bore, is continually to increase the pressure in the water. So in the case of a boiler tube covered with a dense scale, the only way to maintain a constant flow of heat from the furnace to the boiler water is to increase the "heat pressure," so to speak—that is, to burn more fuel. The most important effect of scale is due to the fact that in certain forms it is a wonderful heat insulator. Its chemical composition seems to have little to do with its heat-insulating power, the big question being the density or mechanical structure of the scale. A series of experiments by Prof. Schmidt, of the University of Illinois, gave the following results, showing decrease in heat-transfer efficiency of tubes coated with scale of different thickness and composition:

Character of Scale.	Thickness, Inch.	Composition.	Loss of Efficiency Per Cent.
Hard	1/50	Mostly carbonate ...	9
Soft	1/32	Mostly carbonate ...	7
Hard	1/32	Mostly carbonate ...	8
Soft	1/25	Mostly carbonate ...	8
Hard	1/25	Mostly sulphate	9
Hard	1/20	Mostly sulphate	11
Soft	1/16	Mostly sulphate	10
Soft	1/16	Mostly carbonate ...	11
Soft	1/16	Mostly carbonate ...	12
Hard	1/16	Mostly carbonate ...	12
Soft	1/11	Mostly carbonate ...	15
Hard	1/9	Mostly sulphate	16

This, expressed in dollars and cents, means that with a deposit of 1-9 inch of scale 16 cents of every dollar paid for coal is lost.

The data just given must not be regarded, however, as indicating that the decrease in the heat-carrying capacity of scale-covered tubes can always be calculated with the accuracy that these figures would indicate. The important facts are, though, that the loss is easily prevented, and that the advantages of soft water abundantly justify all expenditures necessary to secure it. Just what the loss is in any particular case could best be determined by comparing the fuel consumption with clean and then with scale-covered tubes, other operating conditions being kept uniform.

Water Softening

The methods employed in softening water may be divided into two main classes, those in which the scale-forming property is removed before the water enters the boiler and those in which the softening is effected within the boiler itself by means of so-called "boiler compounds." As to which one of the two classes of methods should be employed in any particular case, would depend on the size of the plant and on the character of the water to be softened. In the case of waters of abnormal composition, it would frequently be impossible to produce a satisfactory water by either method and a new water supply would be necessary.

It cannot be too strongly emphasized that this question of water treatment is one in which the employment of competent chemical and engineering knowledge is both absolutely necessary and highly profitable, and it would be far wiser to omit all forms of water treatment (involving the use of chemicals) rather than to undertake such without knowing accurately the composition of the water and of the material used to soften it. It is most important to remember that the quality of the water even when secured from the same source varies widely from time to time. These variations are not only seasonal and monthly, but daily, and even hourly. A condition of excessive concentration of the water after a protracted drought may be changed within an hour to a correspondingly excessive dilution by a summer storm. The result would be to decrease enormously the percentage of dissolved matter and to increase, probably to a much greater degree, the amount of suspended matter. As a consequence, a prescribed treatment of the water based on its analysis at any particular time might not lead to satisfactory results if applied at some other period. As an instance of the serious danger of an unintelligent "dosing" of boiler waters may be cited the results of a long series of investigations which have apparently shown that carbonate of soda in solution produces brittleness in boiler steel. Carbonate of soda (soda ash) is used in most water-treating processes, and its unintelligent use may readily lead to a very dangerous condition in the boiler.

Boiler Compounds

Boiler compounds afford a very useful means of boiler-water treatment in plants whose size or value of output would not justify the use of a more expensive method. This would be true of a large percentage of the plants of the country. The chief disadvantage, assuming that they are used intelligently, is the necessity of frequently blowing down the boiler to prevent the accumulation of "sludge" and of alkaline (sodium) salts in the water, both of which cause foaming. Furthermore, this blowing down must be supplemented by washing out, and occasionally closing down the boiler to complete the removal of the sludge and of the boiler compound itself.

Whenever competent supervision of boiler-water treatment is available within the plant organization, it is preferable to soften the water before it enters the boiler, and this must be done when the percentage of scale-forming ingredients is high.

Chemical Removal of Scale

The removal of scale-forming components from water by chemical means, whether before or after entering the boiler, is accomplished by converting the calcium and magnesium compounds into practically insoluble forms, causing them to separate from the water and allowing the material to be removed by blowing

down, filtering or sometimes by settling. Lime and soda ash are generally used for this purpose when the softening occurs before the water enters the boiler. The lime combines with the carbon dioxide which held the calcium and magnesium carbonates in solution. These are no longer soluble in the water after removing the carbon dioxide, and therefore separate from it. In a similar way the sulphate scale is removed by its conversion to insoluble carbonate by the soda ash.

There are in current use in power plants practically only one lime-soda process, of which there are two varieties, differing chiefly in the temperature of the water when treated. In all essential respects the two varieties are similar. The treatment consists of adding to the "raw" water softening agents in carefully controlled amount, which must agree with the composition of the water, mixing these thoroughly within the water, and permitting sufficient time to elapse for the separation of the "sludge" before the water is fed to the boiler.

In the case of the "hot-continuous" process, this separation is effected more rapidly, which permits of less storage capacity than in the case of in the cold-continuous. In all cases, though, it is of the utmost importance to provide sufficient storage space to allow the sludge to be completely deposited before the water is fed to the boiler; otherwise the partially completed softening process will be completed within the heater, and the purpose of the treatment will be largely defeated. Another advantage of the hot process is that it expels the air from the water and so reduces the corrosion.

Zeolite Process

The Zeolite process is entirely unlike the processes described above, and, unlike them, is an artificial material composed largely of sodium compounds which are exchanged for the incrusting (scale-forming) material of the water; that is, the water dissolves sodium compounds from the softener and replaces it by the calcium and magnesium which had caused the hardness of the water. The hard water simply flows over the permutit packed in a cylinder or is forced up through it and flows from it with all scale-forming material removed. After a time the softener must be regenerated by allowing a solution of salt to flow over it, restoring its original composition and activity. The "Permutit" process is a well-known, efficient variety of the Zeolite treatment.

The construction and operation of this softening equipment is extremely simple, and, as already stated, water of zero hardness is furnished. On the other hand, in the case of water to a high degree of temporary or carbonate hardness there is a correspondingly large amount of sodium salts introduced into the water, so that foaming is liable to occur (as is liable to occur when softening water of a similar composition by means of boiler compounds.) In such cases the following modified form of the Zeolite process is used:

The Lime Zeolite Process is an intermittent or continuous tank equipment, as the lime-soda process previously described, is connected through a filter to a zeolite softener. Only lime is used in the tank, the soda compound being secured from the zeolite.

The filter is placed between the tank and the zeolite softener to avoid any sludge coating the permutit particles and so impair its efficiency.

No process of water softening is satisfactory unless the amount of suspended matter is reduced to a minimum. In the case of very finely divided matter this may be done by adding so-called coagulants—alum, for example—but these should be used with extreme caution and always under expert direction. Ordinarily, though, such suspended matter is removed by filters, of which the sand filter with a down flow of the water is the most satisfactory type. They are not expensive, either in original or maintenance cost.

The purpose of the methods described above is to prevent the formation of scale. There is another class of water-treating material used largely to remove scale already formed and to some extent prevent the formation of new scale. Graphite and kerosene are most often used for these purposes. Their action seems entirely mechanical.

Opinions as to the desirability of their use vary from enthusiastic commendation to absolute condemnation, though their use seems generally approved by practical men. Neither should be used, however, in boilers in which there is already a heavy deposit of scale, as the loosening of this and its accumulation in the bottom of the boiler is apt to lead to blistered and bagged boiler metal. Both graphite and kerosene should be used very cautiously. Kerosene, if used in excessive quantity, is apt to distil over and attack gaskets.

There is a very direct relation between softening water and saving fuel. The following are a few cases reported of such economies:

1. A marble company reports a saving of 21 per cent of fuel by softening its boiler water.

2. A crucible steel company, by substituting soft for hard water, effected a saving of 3,600 tons of coal per annum, which, based on current prices, would be valued at $22,000.

3. The Chicago and North-Western Railroad Company, comparing its operating expenses in 1902-3 before and after softening its water supply, reported a saving of $75,000 per annum This saving was effected at a period when coal cost less than one half the prices of today.

4. In addition to these, other cases have been reported in which the profits resulting directly from the substitution of soft for hard water have been reported as varying from 32 per cent on an investment of $7,200 to 71 per cent on an investment of $7,000. These profits resulted largely from the elimination or reduction of operating costs, such as cleaning heaters, piping and economisers, cost of cleaning instruments, interest and depreciation on spare or idle boiler.

5. Furthermore, it has been estimated that the use of hard water in a great number of the locomotive boilers of the country involves the consumption of 15,000,000 tons of coal more than would be needed were soft water only used.

6. A steel company, whose annual output is 50,000 tons, reports a saving of 200 pounds of coal per ton of steel resulting from the softening of its boiler water.

The above are convincing evidences of the opportunity presented to power plant operators for saving, by means of water softening, a very considerable proportion of the coal which will be mined during the current year.

The Wear of Chilled Iron Wheels.

An eminent engineering authority on the subject of chilled iron wheels, states that the life of the chilled iron wheel would be much prolonged were it not for the fact that the tread of the wheel is used for applying the brakes to retard the velocity of the train. The amount of energy consumed per minute in modern brake equipment is enormous in comparison with the tractive effort of the most powerful engine. It is well known that high temperatures are developed in the tread of the wheel in a very short time, giving rise to thermal cracks, regardless of the type of metal of which the tread is composed.

This would not be so serious a matter in itself were it not for the fact that the coefficient of friction between the wheel and rail is irregular, allowing the wheel to slip and slide. These range all the way from the common brake-burn and slid flat to the comby conditions. The friction of the brakeshoe is a variable quantity, depending upon the velocity of wheel, rotation and shoe pressure. At ten miles per hour the coefficient of friction in a modern brakeshoe will reach 40 per cent or more. It is quite evident, with a coefficient of friction as high as this, that the tendency to skid is very great if the friction between the wheel and rail is very much less, as shown by the following variable conditions.

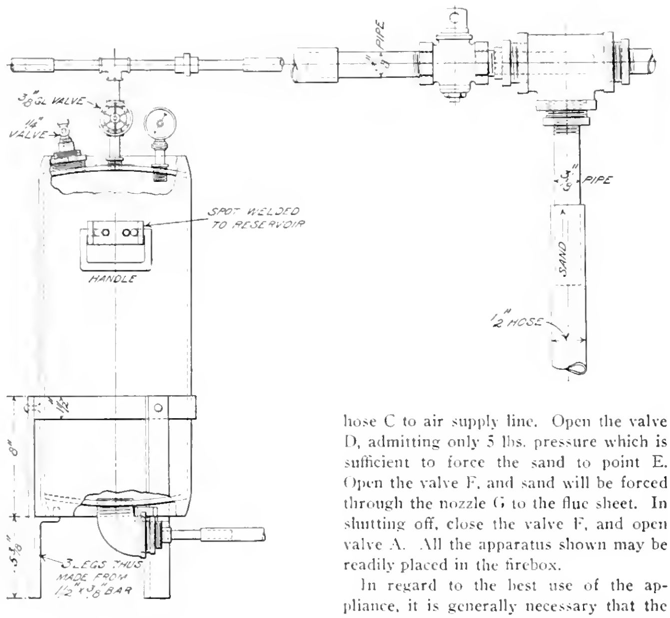
Clean dry rail, 20 to 25 per cent. Clean thoroughly wet rail, 18 to 20 per cent. Oily and moist rail, 15 to 18 per cent. Sleet on rail, 15 per cent. Light snow or frosty rails, 10 per cent.

Sand Blast for Cleaning Flue Sheets for Electric Welding

By A. C. CLARK, Pittsburgh, Pa.

This device, the details of which are shown in the accompanying drawings, consist of a reservoir 10 ins. by 24 ins. or any convenient size. Into the bottom a 2-in. male and female elbow is screwed, and the same is bushed down to 3/8-in. pipe thread and a short 3/8-in. nipple screwed in. A 1/2-in. hose is slipped over this nipple and secured and the hose leads to the other 3/8-in nipple which is screwed into a 3/8-in. by 3/4-in. bushing which is in the 3/4-in. Tee shown in the upper right hand corner of the drawing.

Handles for carrying the reservoir are shown near the top of the reservoir and are so constructed that they turn up to a horizontal position and stop there as the neck of each handle when, in a vertical position, is horizontal, so that when the handle is in a position for carrying the reservoir the end of the handle is against the plate which is spot welded to the reservoir, which is supported by three legs made of 3/8-in. by 1 1/2-in. wrought iron.

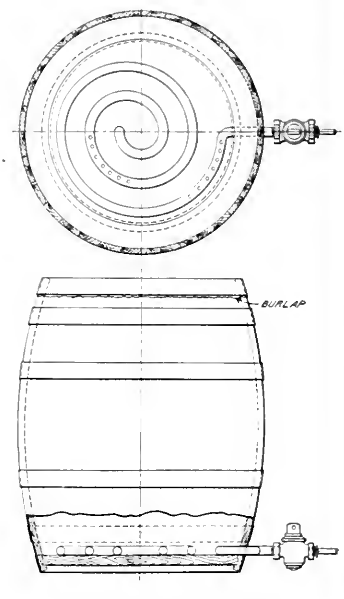


DETAILS OF SAND BLAST

On the top of the reservoir is shown a filling plug B, a globe valve air inlet, and a pressure gauge. The air supply comes through a 1/2-in. hose, then through a 3/8-in. nipple into end of T, and from thence part of the air supply passes down through the valve on the top center of the reservoir, then forces sand through the opening at the bottom of the reservoir and along the hose to the point E, then by opening the valve E the supplementary current of air forces the sand through the opening at the arrow point near E, where the current of sand may be guided over the face of the flue sheet. The reservoir of the size referred to holds about 35 lbs. of sand which should be passed through a No. 8 sieve.

In filling the reservoir it should be noted that there is no pressure in the reservoir by opening the value A, then close valve A, and remove the plug B, and fill with dry, cleaned sand. Then replace and tighten the plug B. In operating, attach hose C to air supply line. Open the valve D, admitting only 5 lbs. pressure which is sufficient to force the sand to point E. Open the valve F, and sand will be forced through the nozzle G to the flue sheet. In shutting off, close the valve F, and open valve A. All the apparatus shown may be readily placed in the firebox.

In regard to the best use of the appliance, it is generally necessary that the sand should be cleaned of dust. A simple apparatus shown in the second drawing will be found very effective. This consists of a barrel with a 3/4-in. pipe coiled and perforated as shown with 1/4-in. holes 1 in. apart on the upper side, and placed in the bottom of the barrel. A 3/4-in. valve is used in admitting air. In operating, remove the upper hoop, fill the barrel with sand, cover the top of the barrel with burlap and replace the hoop. The hoop will keep burlap in place. Turn on the air, and the dust in the sand will be forced through the burlap. The operator engaged in cleaning the sand should use a respirator in addition to a canvas hood furnished with an insinglass window. If loam sand is used the amount of dust is considerable. The whole apparatus is easy of construction, and its use has been much appreciated by expert welders.



APPARATUS FOR REMOVING DUST FROM SAND

Preventing the Growth of Cast Iron.

Amongst the fascinating problems which make engineering science at once a most exacting and a most fruitful study the characteristic behavior of metals under varying conditions provides many curious cases. For example, grey cast iron grows appreciably in volume when exposed to high temperature. This characteristic, which causes much trouble in cast dies, valve seating and other parts, is believed to be due to internal oxidation caused by the penetration of hot gases into the metal. A remedy recently suggested in England is to eliminate free graphite from the surface of the metal, this being the cause of its porosity. Successful results have been obtained by annealing the parts for several days in iron rust at a temperature of from 1650 to 1830 degrees Fahrenheit.

Items of Personal Interest

J. E. Slimp has been appointed general manager of the United Railway Car Company, Boston, Mass., manufacturers of interurban and short line cars.

M. J. McGraw, master mechanic on the Chicago & Alton, will have charge of the northern division, including Roodhouse, with headquarters at Bloomington, Ill.

J. McWood has been appointed master car builder of the Grand Trunk, Eastern Lines, with headquarters at Montreal, Que., succeeding J. Hendry, assigned to other duties.

R. S. Hammond, formerly with the American Steel Foundries, has been appointed Pittsburgh representative of the Whiting Foundry Equipment Company, Harvey, Ill.

D. K. Orr, assistant chief engineer of the Monongahela, has been appointed superintendent, with headquarters at Brownsville, Pa., and his former position has been abolished.

H. H. Maxfield, acting works manager of the Pennsylvania Eastern Lines, with office at Altoona, Pa., has been appointed works manager, in charge of the Altoona shops, with office at Altoona.

E. H. Roelofs, assistant engineer of motive power on the Philadelphia & Reading, with headquarters at Reading, Pa., has resigned to enter the service of the Baldwin Locomotive Works.

Col. James A. McCrea, formerly general manager of the Long Island, has returned from service in France and has been elected vice-president of the Bankers' Trust Company of New York.

W. C. Bower, purchasing agent of the New York Central, with headquarters at New York, has had his jurisdiction extended over the lines west of Buffalo, succeeding G. R. Ingersoll, resigned.

Frank Lafond has been appointed road foreman of engines of the Los Angeles division of the Southern Pacific, with headquarters at Los Angeles, Cal., succeeding R. N. Richardson, assigned to other duties.

A. S. Bartlett has been appointed superintendent of the Mount Washington railway, with office at Base Mt. Washington, N. H. Mr. Bartlett was formerly in charge of the motive power of the St. Johnsbury & Lake Champlain, for over 30 years.

Elliot Reid, assistant to the general manager of the Westinghouse Lamp Company, 165 Broadway, New York, has been appointed sales manager in charge of the activities of the company in both large and miniature classes of lamps in local territory.

C. N. Thacker has been appointed storekeeper of the Toledo, St. Louis & Western, with headquarters at Frankfort, Ind., succeeding H. G. Davis, acting storekeeper, who has been appointed general stores agent in charge of the inspection of ties and other forest products, with headquarters at Frankfort.

C. S. Branch, master mechanic on the Chicago & Alton, under the new jurisdiction, will have charge of the southern division up to the southern yard limits at Bloomington, including also the Chicago, Peoria & St. Louis, with headquarters at Springfield, Ill.

The Anglo-Saxon Trading Corporation, 114A Pitt street, Sydney, Australia, advises through the New York office that the corporation desires to receive catalogues and full particulars from manufacturers of devices relating to the mechanical department of railways.

LIEUT. HOWARD P. COOK

N. M. Canty, assistant superintendent of the American Brake Shoe & Foundry Company, Chicago, has been appointed superintendent of the Pine Bluff, Ark., plant of the Standard Brake Shoe & Foundry Company. The latter has recently made additions to its equipment work, thus doubling its capacity.

Carl B. Andrews, chief engineer of the Oahu Railway & Land Company of Honolulu, Hawaii, has resigned to take up the work of planning and constructing a railway system for the Pampanga Sugar Development Company of Manila, Philippine Islands. The work will require about a year and a half to complete.

N. L. Garland, manager of the Philadelphia, Pa., office of the Safety Car Heating & Lighting Company, has been elected vice-president, with headquarters at Philadelphia, Pa. Mr. Garland was recently relieved from active service with the 87th Battalion, Military Railroad, where he held the rank of major in the Engineer Corps.

Lieutenant-Colonel Felton, president of the Chicago Great Western, has been given the title of commander of the Legion of Honor by the French Government in recognition of his work as director-general of military railways. The United States Government has also honored Col. Felton with the distinguished service medal.

J. H. Minton, senior assistant engineer on the Pennsylvania Western Lines, with headquarters at Pittsburgh, Pa., has resigned to accept a position with the United States Steel Corporation at Pittsburgh. The field work formerly handled by Mr. Minton has been placed in charge of T. M. Bole, assistant engineer, with headquarters at Pittsburgh, and the office details and preparation of plans and specifications in connection with new construction work, formerly handled by Mr. Minton, has been taken over by L. P. Struble, assistant engineer, with headquarters at Pittsburgh.

H. P. Anderson, mechanical superintendent of the Missouri, Kansas & Texas, and the Missouri, Kansas & Texas of Texas, with office at Denison, Tex., has been transferred to the staff of the federal manager, at St. Louis, Mo., in charge of executive and administrative in connection with the mechanical department on the roads under the jurisdiction of C. N. Whitehead, federal manager, and C. I. Evans, chief fuel supervisor, has been appointed chief assistant mechanical superintendent in charge of maintenance of equipment, with office at Denison.

Howard P. Cook, sales agent, Columbia Nut & Bolt Company, Bridgeport, Conn., has returned from war service and resumed his former position as above. Mr. Cook enlisted as a private and was attached to the supply train in the 27th Division, on June 12, 1917. After serving several months as a private and non-commissioned officer at Camp Wadsworth, Spartanburg, S. C., he was commissioned and transferred to the construction division of the army, and assigned as adjutant of the Utilities Detachment, serving in this capacity until recently discharged from the army. His many railroad friends will be glad to learn that he has resumed his former position with the Columbia Nut & Bolt Company.

As announced elsewhere in this issue, Geo. L. Fowler, consulting mechanical engineer, with an office at 120 Liberty street, has become connected with this paper as an associate editor. Mr. Fowler is principally known through his work as a research engineer in the field and

the original work that he has done in that line. He was connected with Dr. Goss in the well-known tests of the radial-stayed and Jacobs-Shupert boiler tests at Coatesville and designed the apparatus for and made the determinations of the character of the circulation in the water legs of the boilers. He has made the only investigations ever undertaken to measure the lateral thrust of each wheel of a locomotive or car against the rail on a curve, and is still engaged on an investigation into firebox stresses, in which he is making an examination of the relative movement of the inner and outer sheets of the firebox due to variations in expansion. This includes temperature determinations of the fire and water surfaces of the inner sheet. He also made the temperature measurements of the wheels when subjected to brake action under moving trains in the A. S. A. brake tests on the Virginian Railway a year ago. In addition to this he has been extensively engaged in editorial work.

Q & C Packing and Lubricator Company.

The Q & C Company, with general offices at 90 West St., New York, announce the formation of the Q & C Packing and Lubricator Co., with general offices at the same address and a factory at 70 Pearl St., Jersey City, N. J. Charles F. Quincy is president, W. W. Hoit vice-president, and F. F. Kister, treasurer, all of the present Q & C Company organization. S. S. Whitehurst, vice-president, and J. C. Smaltz, secretary, are now officials of Steel & Condict, Inc., Jersey City, N. J., where increased manufacturing facilities are being provided to care for the popular Q & C piston rod packing and lubricator.

Charles F. Quincy, as president of the Q & C Company, has made the various Q & C railway car appliances, track tools and locomotive safety devices a by-word of officiency to railroad men for the past twenty-five years, and in a like manner will devote his energies to these latter devices. W. W. Hoit, vice-president, for years has traveled out of New York for the Q. & C. Company, and formerly for the Railway Appliances Company. Other representatives of the Chicago and St. Louis offices will later be assigned to the new company, giving their entire time to the packing and lubricator business. Ample provision has been made to care for the general lines of the Q & C Company, as heretofore.

The packing and lubricator, which have been marketed by the Q & C Company for the past year, promises to develop into a field of large dimensions. Users of Q & C packing are able to obtain thousands more miles of service before renewals than heretofore thought possible. This, to a certain extent, is due to the lubricator which provides a sufficiently uniform lubrication to the piston rod, when and where necessary. No oil is used when the engine is standing, and the unsightly swab is eliminated.

OBITUARY

Oscar Otto.

Oscar Otto, general superintendent of the South Philadelphia Machine Works of the Westinghouse Electric & Manufacturing Company, died on June 30 as a result of injuries received in an automobile accident near Westgrove, Pa. He was born in Manitowoc, Wisconsin, on January 2, 1859, and, after finishing his apprenticeship course as a machinist in the Manitowoc shops of the Chicago & Northwestern, served during several years at various places in Wisconsin. He then entered the service of the Northern Pacific, at Tacoma, Wash., going from there to the Oregon Short Line, at Salt Lake City, Utah. In 1898 he returned to the service of the Chicago & Northwestern as superintendent at the Chicago shops. In June, 1909, he accepted a position as general superintendent of the Westinghouse Machine Works, at East Pittsburgh, Pa. When the Westinghouse Company opened its new plant at Essington, Pa., Mr. Otto supervised the installation of the machinery, and later, in February, 1918, he was transferred to the new works, where he remained until his death.

Matthew J. McCarthy.

Matthew J. McCarthy, superintendent maintenance of equipment of the Baltimore & Ohio R. R., Western Lines, with headquarters at Cincinnati, Ohio, died at his home in that city on July 12. He was born at Susquehanna, Pa., in 1868 and entered railway service in 1889 as an apprentice with the Erie R. R. Later he was with the Chicago, Burlington & Quincy R. R. at Burlington, Iowa, as machinist, inspector and general foreman; for four years was division master mechanic on the Michigan Central R. R. at St. Thomas, Ont., and for two years was division master mechanic on the Lake Shore & Michigan Southern R. R. at Elkhart, Ind. He was with the Cleveland, Cincinnati, Chicago & St. Louis as superintendent of the shops at Beech Grove, Ind., for three years, and then was assistant superintendent of motive power at Indianapolis for a year and a half. On January 1, 1913, he was appointed superintendent of motive power of the Baltimore & Ohio Southwestern R. R. and the Cincinnati, Hamilton & Dayton R. R., with headquarters at Cincinnati, and was later made superintendent of motive power on the Baltimore & Ohio R. R., which position he held at the time of his death.

Bulletins, Catalogues, Etc.

Baldwin Record No. 93.

The Baldwin Locomotive Works War Industries forms the subject of a highly interesting, finely illustrated pamphlet of 24 pages. It will be recalled that when the war broke out in August, 1914, the manufacturing facilities of the company were promptly placed at the disposal of the Allied governments. Russia was especially in need of railroad equipment, and S. M. Vauclain, then senior vice-president of the company, visited Russia in the fall of 1914, and also early in 1915, and secured extensive orders. 30 Mallets were rapidly completed and shipped. This order was followed by others, including gasoline locomotives. Among the most notable achievements was the filling of an order for the French Government for twenty narrow-gauge tank locomotives. This order was received on November 3, 1914, and the twenty locomotives were ready for shipment on November 21. Two hundred and eighty locomotives followed of the Pechot type, a double-ended type weighing about 14 tons. Others of heavier types followed in amazing rapidity. In 1916-17 Great Britain was supplied with 960 locomotives, nearly half of which were heavy locomotives of the standard gauge. The War Department of Great Britain stated that if it had not been for the prompt and efficient deliveries of Baldwin's locomotives, some of the accomplishments of the British Army could not have been possible.

This was not all. On the Eddystone property of the company two large plants were erected for the manufacture of war munitions. One of these was leased to the Remington Arms Company, and afterwards acquired by the Midvale Steel and Ordnance Company. The capacity of this plant reached 6,000 rifles per day, and supplied nearly two-thirds of all the rifles used by the American Army. The second plant was entirely owned by the Baldwin Locomotive Works and constituted one of the greatest industrial achievements of the war.

At the same time about 300 locomotives were furnished to the American Government, and for the first time in history the locomotives were shipped entire, with the exception of the smoke stack. The various types of locomotives are all illustrated in the pamphlet, together with heavy guns mounted for rail transport, the whole forming a unique memento of the war period.

MacRae's Blue Book.

The 1919 edition of MacRae's Blue Book was issued last month and shows a continuation of the growth that has marked its progress since its inception ten years ago as a high-class advertising medium, and its improvement and increase in volume year by year is the best proof of its popular favor. The work is divided into six sections, including addresses, classified materials, trade names, miscellaneous data, standard prices and advertising section. The classified material section, embracing over 10,000 classifications, the names of the various manufacturers of iron and steel products, building construction materials, railway supplies, etc., is admirably arranged. The same may be said of the other sections rendering the desired information easy of procurement. The work extends to 1,600 pages, about 10 per cent more than last year, 580 of which are devoted to advertising, of which there are over 1,600. Of mechanical data there are 250 pages, a valuable volume in itself. The publication had the distinction of being of much service in the government departments during the war period. The book is published by MacRae's Blue Book Company, Railway Exchange, Chicago, Ill.

Railroad Problems.

Robert S. Lovett, president of the Union Pacific System, has contributed interesting comments on the railroad problem, and proposes certain methods for solving it. The comments extend to 76 pages of a finely printed pamphlet, and starting with the assumption that public opinion overwhelmingly favors the continuance, by private ownership, of competition in service and facilities furnished by railroad carriers, and that this will be established, he comes to the question of the existence of the weaker roads being supported by the strong, when it is well known that the credit of the strongest has not been any too good during the last ten years. Mr. Lovett believes that the absorption of some of the weak lines by the strong, upon fair terms, should be promoted, but no consolidation should be permitted which eliminates competition; and Congress should adopt a sound railroad policy and fix rates sufficient to enable the carriers to provide safe and adequate service, and attract new capital necessary to the public interest. Furthermore, the railroad transportation system should be rescued from the irresponsible and conflicting State agencies, and brought under uniform national control because executive and administrative functions cannot be efficiently exercised by boards, commissions or committees. We have had enough of penal authorities, and Mr. Lovett believes that a Secretary of Transportation should be appointed with the same powers as other secretaries in the organization of the Government, and a multitude of hindrances and unnecessary adjuncts would pass to the scrap heap.

Accident Bulletin.

The Interstate Commerce Commission has issued Accident Bulletin No. 69, containing details of collisions, derailments and other accidents resulting in injury to persons, equipment or roadbed arising from the operation of railways used in interstate commerce during the months of July, August and September, 1918. The investigation of accidents is now very thorough, being regularly conducted by the Bureau of Safety, and in addition to this the general increase in the cost of materials and labor has had the effect of increasing to some extent the number of railway accidents classified as train accidents solely because the damage to property exceeded the reported minimum figure of $150. In spite of this fact it is gratifying to note that the number of accidents resulting in casualties to persons is below the average of several preceding reports, the list of persons injured in the nine months ending September, 1917, being reported as amounting to 52,095; killed, 7,196; while during the same period in 1918 the number of persons were reported as 49,178; killed, 6,595.

Railway Stockholders.

The Bureau of Railway Economics has issued Bulletin, Miscellaneous Series, No. 33, showing the number of railway stockholders on December 31, 1917, the date on which the railway system of the United States passed into the hands of the Government for war operation. The statistics are interesting as showing how many persons owned the railways and what was the amount of their holdings at the period referred to. The approximate amount of railway stock in the hands of the general public at that time was $6,377,551,082. This stock was in the hands of 636,208 holders, the average amount of holdings being $10,024. The fact that corporations, estates and similar holders are entered but once, and that their holdings belonged actually, though indirectly, to many others, greatly increases the number though not enumerated.

Districts are classified in the Bulletin, but the chief outstanding fact is that 8,301 of the stockholders held about one-half the number of the outstanding shares of stock of these railways, and that nearly the same number, variety and value of holdings had been maintained for several years preceding. The slight variations as compared with previous records of statistics are presented with microscopic exactness, but in the matter of amounts of interest on the investments the Bureau is as silent as the Sphinx.

Railway and Locomotive Engineering

A Practical Journal of Motive Power, Rolling Stock and Appliances

Vol. XXXII 114 Liberty Street, New York, September, 1919 No. 9

Railway Mounts for Long Range Guns of the U. S. Navy

Among the remarkable things achieved by the United States in the preparation for sustaining its part in the war was the construction of some railway mounts been originally built for certain battle cruisers. These guns could throw a 1,500-lb. projectile at a muzzle velocity of 2,800 ft. per second, which, with a high eleva- placed upon railroad mountings they would be a valuable addition to our artillery, in that they would throw a heavier projectile with greater accuracy than any

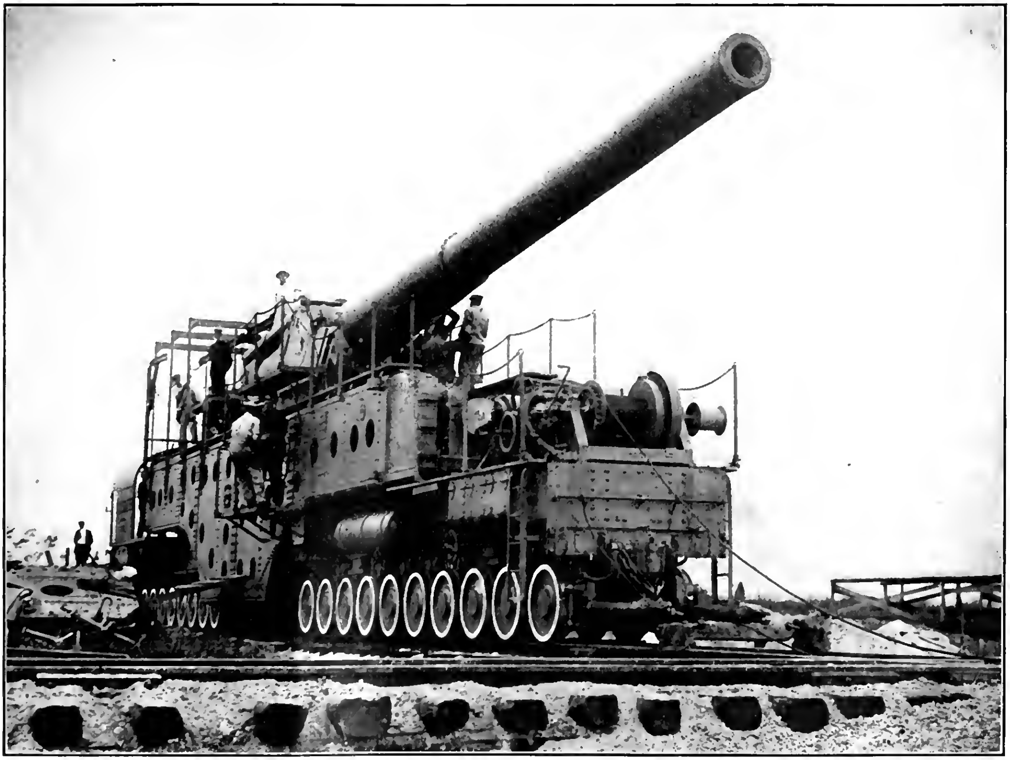


Photo by International Film Service

RAILWAY GUN CARRIAGE AND 12 INCH GUN, THIS MOUNT RUNS ON FORTY WHEELS, AND WAS BUILT BY THE BALDWIN LOCOMOTIVE WORKS FOR THE BUREAU OF ORDNANCE, NAVY DEPARTMENT.

for certain long-range navy guns that became available in November, 1917. There were some 14-in., 50-caliber guns that had tion, gave an effective range of nearly 30 miles.

It was felt that if these guns could be gun previously placed on movable land mounts.

As soon as it was decided to do this,

work on the plans was started, and they were completed in less than 30 days and were ready for bids on January 25, 1918. These plans called for five railway gun mounts for as many 14-in. guns, six locomotives and six complete trains of cars, or 75 cars in all.

The contract for the gun mounts and locomotives was awarded to the Baldwin Locomotive Works, which undertook to make the delivery on June 15. The project, however, was speeded up so that the first mount was completed and moved out of the Baldwin shops on April 25, or 72 days from the date that the bids were opened and 20 days ahead of schedule time.

It was the original intention to have this battery operate in connection with the British forces, but on May 23 Gen. Pershing cabled, requesting the immediate shipment of the entire expedition to St. Nazaire, and the first shipment was made to that point on June 20. The delay was caused by the torpedoing of an inbound steamer intended to take the guns.

Anticipating the need of skilled men for erection work in France, 200 experienced railroad mechanics were selected from the men at the Great Lakes Training Station and sent to France a little before the first shipload of material sailed.

The first shipment arrived at St. Nazaire on July 8; the second and third on July 21. The locomotive and car erection began July 20. The erection of the first gun was begun July 30. The first gun train was completed August 11, and the first two left for the front on August 17 and 18. The first gun mount was ready 12 days after the girder was unloaded from the ship, and the first two trains were ready 22 days after erection started. The first gun was fired against the Germans on September 5, or less than 250 days from the time that the project was first thought of.

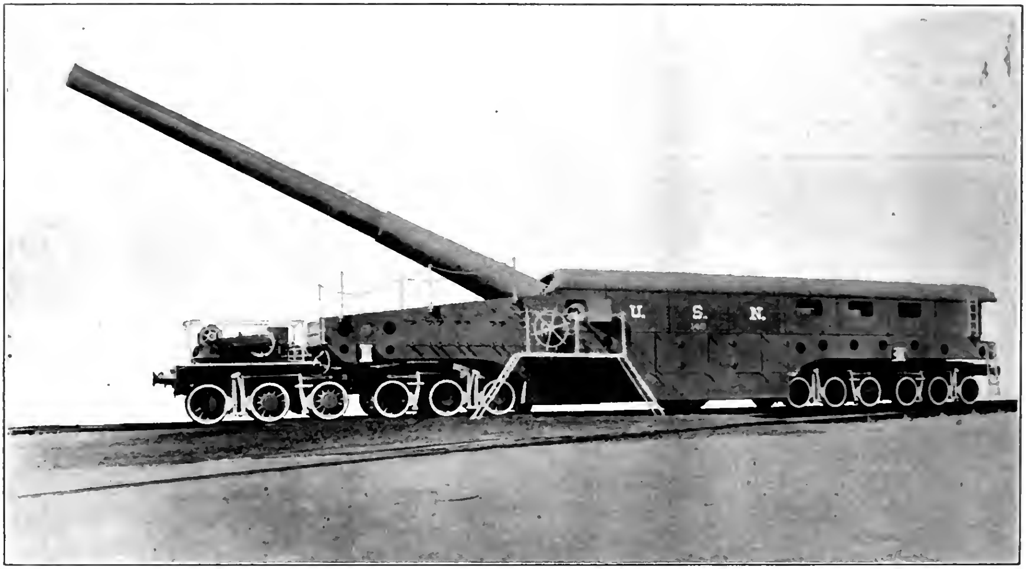
The total weight of the mount is about 550,000 lbs. It is carried on four six-wheeled trucks, or 24 wheels in all, so that the weight per wheel was about 22,900 lbs. This was thought by the railway authorities of France as too heavy a wheel load to be moved over certain of their bridges, and protests against such a movement were registered. Lieut.-Com. Buell, who had charge of the erection, answered the protest as soon as the first mount was ready by simply hauling it out and over one of the bridges in question.

The truck axles were designed to sustain a maximum axle load of 63,000 lbs. The kinetic energy of the gun is about 4,000,000 ft. lbs., which is absorbed through a hydraulic brake in the recoil of 44 in. in the slide, and when firing on the rails the movement to the rear is about 26 ft.

Arrangements were also made for firing the gun from a pit, when the load is transmitted to foundation members in the form of a heavy grillage construction of castings and structural steel shapes, the load being limited to about 4 tons per sq. ft., according to official data.

The cut at the rear of the mount was formed of ¼-in. armor plate and enclosed the main girders as well as the breech of the gun.

When the first gun was ready it was desired to make a test before moving up to the firing line. The longest range that was available in France was one of 14 miles. Three shots were fired over this range and they all fell within a square of 150 ft. on a side. They were then sent to the front and put into action on September 5, as already stated. The effect was tremendous. They served the purpose of destroying the railroad at Laon and breaking the German line of communication from that point to his western front, necessitating a long detour to the rear.



ONE OF THE 14 INCH NAVAL RAILWAY GUNS DESIGNED, BUILT AND PUT INTO OPERATION BY THE BUREAU OF ORDNANCE OF THE NAVY DEPARTMENT.

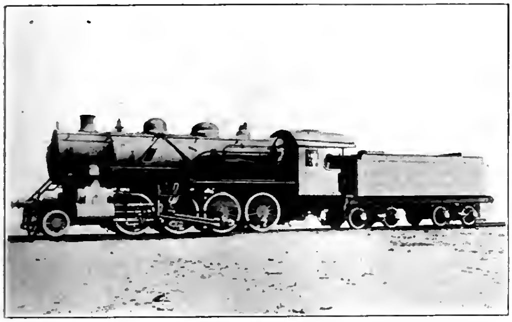
The locomotives used to haul the battery train were of the consolidation type and weighed 139 tons, of which 83 tons were for the locomotive and 56 tons for the tender. The cars were of the ordinary American type of box car, carried on bogie trucks, but fitted with the French type of couplers and buffers.

Having accomplished this on the spur of immediate necessity, attention was turned to the further development of mobile mounts and greater perfection on railway mounts. The results of this work of development are shown in our frontispiece illustration of the latest form of heavy gun mount produced in the United States. The car is carried on forty

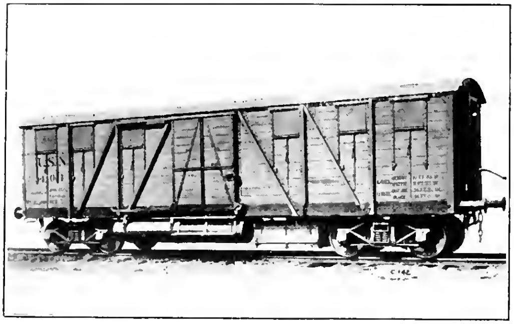
wheels instead of twenty-four, while the caliber of the gun is but twelve inches instead of fourteen.

This gun and mount is now at the naval proving ground at Dahlgren, Va. Like its predecessor it was built by the Baldwin Locomotive Works.

The immediate forerunner of this latest development was the 12-in. gun mount. The mount referred to has neither recoil nor traveling mechanism. The entire mount is about 105 ft. long and weighs 575,000 or something more than the mount for the 14-in. naval gun. This design can be transported at a speed of 40 miles an hour over a standard gauge roadbed and will take any curve met with in American practice. This mount has no traverse for the gun and when it is to be used the track is laid on a curve and the gun is trained on its objective by moving back and forth with a gasoline engine. A special hand translation mechanism being used for spotting the mount in the exact position.



ONE OF THE SIX LOCOMOTIVES OF THE RAILWAY MOUNT EXPEDITION.



ONE OF THE 75 CARS CONSTRUCTED FOR THE RAILWAY MOUNT EXPEDITION.

The principal parts of the car body consist of bridge girders, span bolsters connected to 8-wheel trucks, trucks, bearing stringers and sleepers, lifting wedges and loading mechanism. The gun is supported on trunnion beds, which are carried on top of the girders. The gun can be elevated from —4 deg. to + 40 deg.

The slippers consist of wooden beams placed crosswise under the car body, supported by the elevating wedges which raise and lower them into position. The bearing stringers are made up of eight lines of 12-in. steel I-beams. The lifting wedges are operated by handles, one man being placed at each handle. No special track preparation is necessary other than to lay the stringers and to see that the track is well ballasted. In the firing the entire piece slides to the rear for about 15 ft. and after each shot the mount is returned by means of the power winch and the hand translating device. The 12-in. gun is 50 calibers in length and is one of the most powerful in existence. The muzzle velocity is 3200 ft. per sec. and the range is approximately 30 miles.

We are indebted to the American Society of Mechanical Engineers for the illustrations of the locomotives, cars, and 14-in. naval gun mount.

Improved Lighting Equipment.

So much progress has been made in the art of light production that the demands for illumination of the requisite intensity, adequately controlled as regards direction, diffusion and other desirable qualities, can be fully met. With modern lamps and accessories it is not only practicable, but highly economical to furnish light of an intensity comparable with average daylight, so that no harmful results can ensue and production be kept at a maximum. Statistics prepared by lamp manufacturers covering periods during the last four or five years show a greatly increased production in the output of manufactures as compared with the conditions of previous limited lighting equipments. These statistics may show exceptional cases, but in any event the improvement in lighting equipment is of prime importance, and the man best equipped to determine the details of installing new appliances is, of course, the man best informed regarding the requirements of the particular situation and the available lighting expedients. These are the illuminating engineers, who should be consulted in all cases.

The New Standard Coupler

In the report of the committee on couplers that has been sent to the members of the mechanical section of the American Railroad Association for approval as a standard, it is recommended that it shall be made mandatory that all new cars built after a certain date be equipped with the new M. C. B. Standard "D" Coupler with a 6 in. by 8 in. shank. Also that after the present stock of 5 in. by 7 in. couplers are used all future renewals shall be made with couplers having the 6 in. by 8 in. shank, and that all cars built after June 1, 1920, without this new coupler shall be refused in interchange. Of course, cars that are at present equipped with the couplers having the 5 in. by 7 in. shank can have repairs made in kind.

Westinghouse Air Brake Home Building Company Organized.

The housing facilities, which at present are inadequate at Wilmerding, Pennsylvania, the home of the Westinghouse Air Brake Company's works, are to be extended at once by the erection of a number of new dwellings for the families of the employees. An official announcement is made of the organization of the Westinghouse Air Brake Home Building Company, with a capital of $1,000,000, for the purpose of transacting all business relative to the real estate and dwellings which have been transferred by deed to this company by the Westinghouse Air Brake Company. It includes the ownership of over 400 houses and considerable vacant property in the borough of Wilmerding and the adjacent territory.

The officials of the new organization are A. L. Humphrey, chairman of the Board of Directors; C. A. Rowan, president; W. S. Bartholomew, vice-president, and H. C. Tener, secretary. In addition to the first three mentioned above, J. F. Miller and G. W. Wildin are included in the Board of Directors. S. R. Gittens has been appointed manager. Since the Westinghouse Air Brake Company built its first house for employees in 1890 there has never been an increase in rents and the new company will carry out the same policy.

The plans of the new company are meeting with warm approval among the employees, and their success is assured.

Electric Freight Locomotive of the Pennsylvania Railroad Designed for Use on Heavy Grades

For some time past there has been in service, on the Paoli electrified section of the Pennsylvania Railroad, a type of electric freight locomotive designed for use on the heavy grades between Altoona and Johnstown, Pa. From Altoona, going West, the road climbs to the summit of the Allegheny Mountains up a grade about 12 miles long that runs up to 2 per cent for a part of the distance and includes the well-known horseshoe curve. From Gallitzin, the summit of the grade, there is a drop to Johnstown, about 24 miles, over a grade of 1 per cent.

The engines are designed to be operated at two speeds, namely 10.3 and 20.8 miles per hour, or any intermediate speed from zero up.

Like the earlier electric passenger locomotives of the same road that are used for operating out of the New York terminal, these freight locomotives are built in two units insofar as the running gear and electric equipment is concerned, but instead of having two cabs, one on each running unit, the new locomotives have a single cab carried by the two units which are pivoted to it.

When the first passenger locomotives were designed a careful study of all locomotive designs built up to that time was made, and one or two engines were built for trial purposes before the final design was decided upon.

One point that was given most careful consideration was the location of the motors. It had been urged at the meeting of more than one railroad club that the designers of electric locomotives could well look to and imitate the work of steam locomotive builders. Here it had been found that for ease of riding, a locomotive with a high center of gravity was more satisfactory than one where the center of gravity was low, and that the whole tendency of the work of recent years had been to raise the center of gravity of the machine far above what it had been in earlier days. Further than this, some of the track troubles that had been experienced with engines of other designs had been attributed to their low center of gravity.

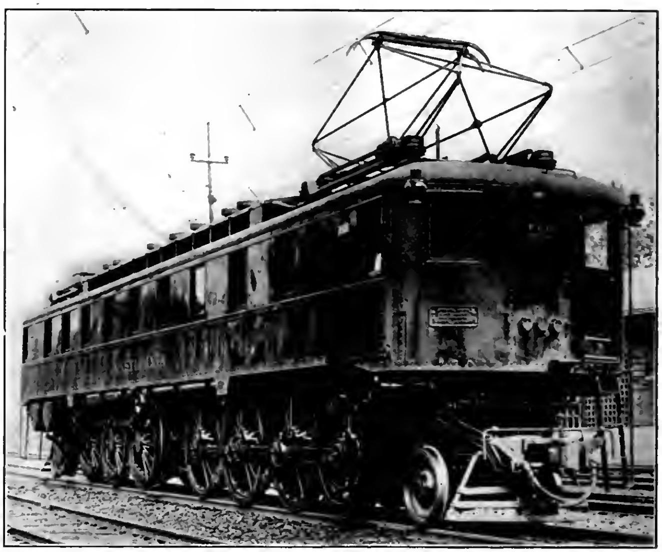
Accordingly, in the earlier designs of the Pennsylvania locomotives, the heavy driving motor was set up in the cab and raised well above the floor, with the idea in mind of securing a high center of gravity. Connections were made from the motor to a jackshaft by means of a connecting rod that worked diagonally downward, with side rods running horizontally from the jackshaft to the crankpins on the driving wheels. It was recognized, at the time, that this diagonal connecting rod was undesirable, but the disadvantage was thought to be more than offset by the high center of gravity thereby attained.

As far as riding qualities were concerned, the engine more than came up to expectations. At speeds of from 60 to 70 miles per hour on a straight track they ran with remarkable smoothness and without manifesting the slightest tendency to "nose" that was so characteristic of other electric locomotives having a lower center of gravity.

operation of the double set of motors.

The current supplied to the line is a 11,000 volt 25 cycle single-phase current, which is taken by the primary of a static transformer.

Each motor is capable of developing 1,200 horsepower, so that the four give the locomotive a rating of 4,800 horsepower, which, being converted to tractive effort, means about 87,000 pounds at 20.8 miles per hour. As the rating of the engine for continuous working is 4,000 horsepower, the corresponding tractive effort is about 72,000 pounds. Converted to tonnage rating this means a capacity to



PENNSYLVANIA RAILROAD ELECTRIC FREIGHT LOCOMOTIVE.

The freight locomotive under consideration has a somewhat different motor arrangement. Instead of the one powerful motor connected to the jackshaft by rods, there are two motors driving the jackshaft through herringbone pinions. This lowers the center of the motors some distance below that of the single-motor engine, but does away with the diagonal connection. But the center of gravity of the engine as a whole is probably not greatly lowered thereby, if at all. There is more electric apparatus in the cab, among which is the phase converter which changes the signal phase current coming to it from the line through the transformer to the three-phase current used for the

haul 2,300 tons at a speed of 20.8 miles per hour up a 1 per cent grade, or 4,100 tons up a .5 per cent grade at the same speed. Under this rating, two locomotives are expected to handle 3,900 tons westbound, where the ruling grade is 2 per cent, and 6,300 tons eastbound, where the ruling grade is 1.33 per cent.

Among the interesting details of the engine the jackshaft gear is one of the first to attract attention. It is so constructed and the rim so connected to the center by springs, that the whole power is transmitted through them, and yet the design is such that up to an exertion of 25 per cent of its horsepower the gear acts practically as a solid gear. This is

the regular Westinghouse design that has been extensively used elsewhere. The jackshaft itself is 11⅛ in. in diameter and has a 3 in. hole running through it from end to end. The ends are tapered to receive the gear, which has a long hub. This hub extends through the brass and thus forms the bearing for the shaft. A key on the shaft holds the gear in place and insures a proper quartering of the cranks. The crankpin is 8¼ in. in diameter and has a throw of 30 inches.

The central bumpers of each unit are steel castings whose vertical faces are in the form of a circular arc with radii equal to the distance from these faces to the center of the pivot on which the cab is carried. So that, as the units move and assume various angles with each other, when passing curves, these surfaces are always in rolling contact.

At the center of the cab there is an electrolyte well carried beneath the framing, and riveted to the bottom of this well there are two steel castings which form the two legs of a jaw similar to the regular pedestal jaws of a locomotive. These jaws are connected by a binder of the usual type, the latter having vertical extensions that rise and bear against the inside faces of the pedestal legs. The two bumper castings have a bearing against these projections and are fitted with wearing strips at the point of contact. As the pedestal has a lateral motion, relatively, to the bumpers when traversing curves, the bearing faces of the latter have a concave surface concentric with the convex surface of the bumpers where they come into contact with each other. The convex surfaces are also fitted with wearing strips. Both these and those on the concave faces are of steel, 1 in. thick, and are held to the bumpers by rivets with countersunk heads.

The locomotive is fitted with two compound compressors for the operation of the air brakes, each compressor having a capacity of 150 cubic feet of free air per minute. The compressors are of the four-cylinder type and are driven by a four-pole commutator type Westinghouse motor for alternating current of 150 volts, and will develop 35 horsepower at 1,200 revolutions per minute.

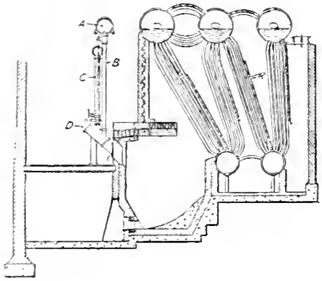
There are also two sets of motor-driven blowers, that are used for cooling the main motors, phase converter and main transformer, and if one set should fail, the arrangements of dampers and ducts are such that air can be suppliedto all of the apparatus from the other rest. This also makes it possible to shut off one blower and so cut down standby losses when the engine is switching.

Although operating normally as a three-phase motor, the blower motor can run single-phase and thus act as a phase converter for the circulating motor pumps.

These engines are still working on the Paoli section of the road and are being watched and subjected to experiment and changes of detail before being finally adopted for the work for which they are intended. In this several matters have developed which needed change in detail, but the general features of the engine are as they have been here stated and will probably need no revision.

Powdered Fuel.

The combustion of powdered fuel, which has been engaging the attention of several eminent engineers in Great Britain, is favorably reported on. Our illustration shows a system as applied to a Stirling boiler. The large horizontal pipe A is a circulation main, conveying a mixture of air and powdered fuel, the coal being conveyed while in suspension in the air. This mixture is too rich in coal to be inflammable, and moves at a velocity of about one mile per minute. Coal and air are tapped off in any desired quantity and



POWDERED FUEL BURNER ON STIRLING BOILER.

fed by means of the pipe marked B. The pipe marked C supplies the secondary air necessary for combustion. A control valve is placed at the pipe B, and as near as possible to the distributing main, while the air pipe C is fitted with a valve gate just above the burner, this valve controlling the supply of secondary air to the burners. The flange D at the end of the burner is so arranged that it may be opened to admit a certain amount of induced air if desired, and is also a convenient inspection door for the use of the boiler attendant.

Actual combustion does not take place until the velocity falls at the entrance to the combustion chamber. The design and construction of the burners is said to be of primary importance.

The use of powdered fuel in America has long passed the experimental stage. In repeated tests between two locomotives, it was estimated that a saving of 23 per cent was obtained by using pulverized fuel on the one as compared with the other, which was hand-fired. Very satisfactory results were obtained, giving all steam required with perfect control, burning 60 per cent anthracite and 40 per cent bituminous coal. In Brazil it has been possible to utilize the native fuel, which otherwise could not be satisfactorily handled in a locomotive. The high cost of imported coal is thus saved. There are now several hundred powdered fuel installations in the United States, and it has been clearly demonstrated that pulverized fuel is particularly economical where large quantities of coal are required, but the boilers must be especially equipped with combustion chambers suitable for the maximum amount of coal required to operate the boiler, the large chambers eliminating refractory troubles. All qualities of coal can be burned regardless of quality, thereby insuring large economy. Tests with special reference to pulverized fuel used on locomotives were seriously interfered with by the conditions imposed by the war, but it is expected that in the near future further developments leading to more rapid installations will be made.

Exports of Steam Locomotives

The Bureau of Foreign and Domestic Commerce, reporting domestic exports from the United States by countries during June, 1919, shows a slight falling off in the number of steam locomotives as compared with the previous month, but a large number of unfinished orders were on hand. It will be observed that over 60 per cent of the total number of locomotives exported are destined for European and Asiatic Russia, among the latter being a number of powerful freight locomotives for the 5-foot gauge of the Trans-Siberian Railway. The official report is as follows:

Countries.	Number.	Dollars.
France	3	82,184
Russia in Europe	20	265,065
Spain	1	6,800
Canada	11	68,510
Cuba	2	29,650
Brazil	6	331,450
China	4	200,400
British India	1	22,850
Russia in Asia	30	1,350,000
Total	78	2,356,909

American Locomotive Company.

At a meeting of the directors of the American Locomotive Company held last month, William H. Woodin, president of the American Car & Foundry Company was elected a director of the American Locomotive Company in place of the late George R. Sheldon. W. Spencer Robertson, secretary of the company, was also elected a director to fill the vacancy caused by the resignation of Harry Bronner. A quarterly dividend of 1½ per cent was declared on the common stock and the usual dividend of 1¾ per cent on the preferred stock.

Superheaters for Stationary Power Plants

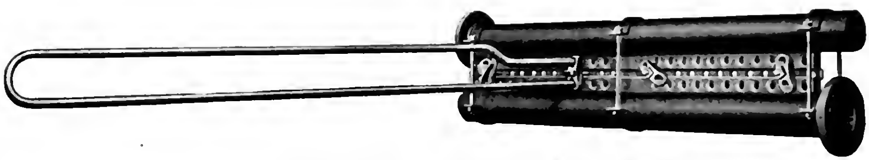
The Elesco Type Developed by the Locomotive Superheater Company

Details of Construction and Assembling

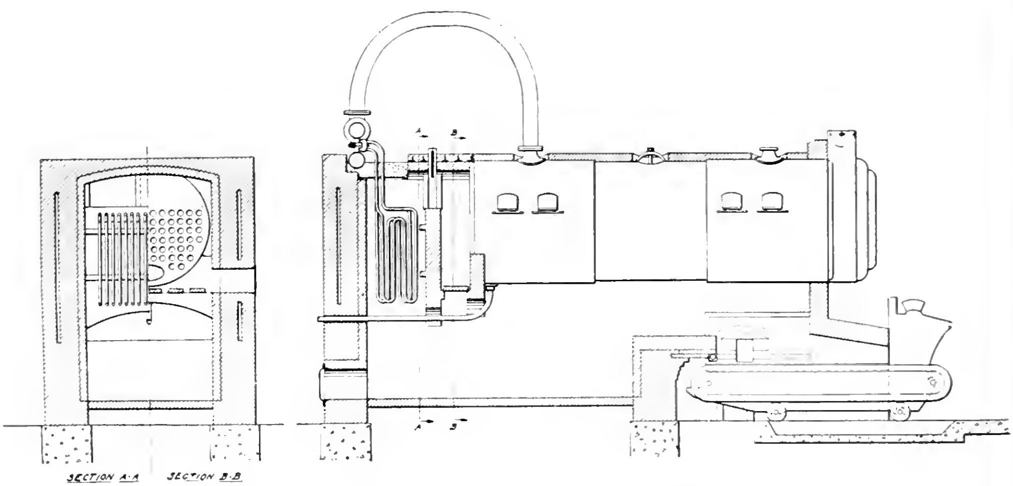
The application of the use of superheated steam to stationary power plants, as is well known, is much older than its application to locomotives, but in spite of its age it has not until recently, been extensively used in the United States.

The Locomotive Superheater Company, which has done so much for the development and application of superheaters to locomotives has now entered the field of stationary practice with a design which it calls the Elesco superheater.

The principle of this superheater is identical with that used for locomotive work. That is to say, there is a header connected to the boiler which serves as a receiver of the superheated steam. From this header a number of small pipes lead off forming loops in the passage for the products of combustion and returning to a similar header into which they deliver the steam that has become superheated



SUPERHEATER HEADER SHOWING METHOD OF ATTACHING UNITS.



ELESCO SUPERHEATER ADAPTED TO HORIZONTAL RETURN TUBULAR TYPE BOILER.

in its passage through them, the general construction of the whole being shown in the engraving.

The exact design of the header and tubes will, of course, vary with the type of boiler to which they are to be applied. This statement also applies to the location in the gas passages where the superheater is placed. There are, however, certain fundamentals governing the choice of this location that is applicable to all boilers.

The fact that the temperature of the superheated steam is higher than that of the saturated steam from which it is formed, and as the water in the boiler is of approximately the same temperature as that of saturated steam, it follows that the superheated steam will extract less heat from gases of a given temperature under the same conditions than will the water, because the passage of heat through a metal plate varies in the difference in the temperature on the two sides, and the greater the difference the more rapid the passage of the heat. Hence, in order to obtain the maximum of efficiency, that is, that the gases, discharged into the uptake, should have the lowest possible temperature, they should be made to pass over heating surfaces on the other side of which should be the coolest water in the boiler, just before reaching the uptake. This, then, requires that the superheater should be so located in the gas passages that, after the products of combustion have swept over them, they should pass over other and cooler heating surfaces before reaching the uptake. It also indicates that it should be located as close as possible to the point of the highest temperature of the furnace without interfering with the process of combustion.

Accordingly in the diagrams of con-

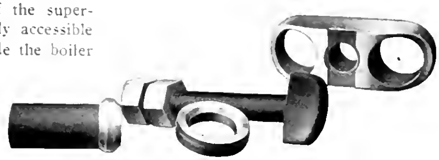
struction that have been sent out, the superheater under consideration is shown above the tubes in the first turn of the gases in the inclined water-tube boiler; beneath the back arch of the return tubular boiler; between the first and second nests of tubes in the Stirling boiler and in corresponding places in others.

As the headers form no part of the superheating portion, and as it is desirable that the connections of the superheater units should be readily accessible the headers are placed outside the boiler setting so that they can be reached without entering the furnace.

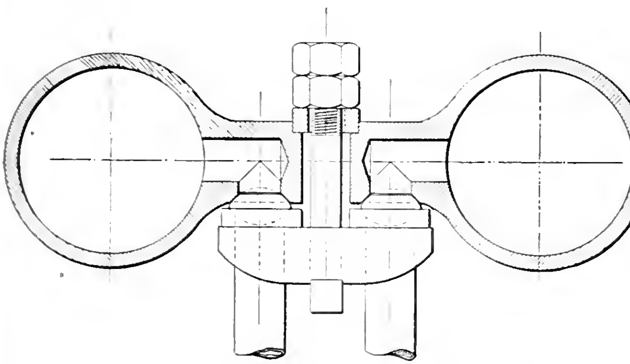
Steam is a poor conductor of heat. Hence it is desirable that in order that it may be superheated, it should pass over the heating surface and this suggests the use of a large number of small tubes rather than a few large ones, and this is another feature of the design that is common to all of these superheaters. The construction of the superheater is very simple. The two ends of the unit pipe are brought close enough together to be taken by a single yoke. Each end is fitted with a ball end that bears against the seat in the header, while back of it and forming a seat for the yoke is a washer that will accommodate itself to any lack of true alinement of the balls and make a seat for the yoke. This makes a metal-to-metal joint between units and the headers. The actual contact between the ball on the header is a ground joint.

It will be seen from the detail engraving that the assembly is very simple. The washer and yoke are slipped over the unit before the balls are put on. Then the balls are brought into place against their seats in the header and the bolt passed through the hole in the yoke and header holds them in place. To remove any unit for inspection and repairs, it is simply necessary to slacken, loosen and withdraw the holding bolt and the unit is free. No opposite holes are needed in the header and any unit can ordinarily be removed without disturbing any of the others.

It is evident, too, that any degree of superheat can be obtained by a regulation of the number and length of the units. The whole system is made of steel from which a maximum of durability can be obtained.



BALL END OF UNIT PIPE WITH CLAMP BOLT AND WASHER USED IN ATTACHING TO THE HEADER.



BALL JOINT CONNECTION BETWEEN UNITS AND HEADER.

Improved Railroad Ties.

The Committee on Interstate and Foreign Commerce have been making investigations in regard to the merits of a substitute for wooden ties for use in railroads. Several railroad officials representing the Chicago & Alton, and the Wheeling & Lake Erie have furnished data in regard to a composite form of tie embracing a steel T shape, 8 ft. in length by 12 ins. in width, with a central wing 5 ins. in depth. At the bearing of the rail there are two treated oak blocks, 5½ ins. in width by 6 ins. deep and 18 ins. long to which the rail is spiked in the usual manner. The rails are insulated from the metallic portion of the tie, so that track circuits are not disturbed. The bearing blocks are bolted to the steel shape, thereby being held securely in place. The ties are spaced 14 to each 33 ft. rail. Several modifications of the design have been submitted. The Tri-city Steel Company of St. Louis, Mo., have had some of them in service over three years. The report of the committee will be looked for with interest.

Report of New Equipment.

On July 1, 1919, the total number of United States Railroad Administration standard locomotives turned out for service was 1,504, leaving orders for 526 unfinished at that date. The number and classes delivered are as follows: Light Mikado, 553; Heavy Mikado, 233; Light Mountain, 35; Heavy Mountain, 14; Light Pacific, 36; Heavy Pacific, 13; Light Santa Fe, 75; Heavy Santa Fe, 130; Light Mallet, 15; Heavy Mallet, 47; Six-wheel Switch, 230; Eight-wheel Switch, 143.

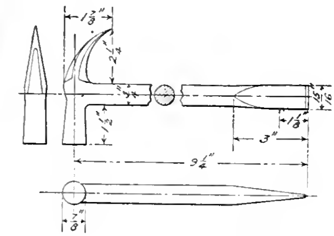
On the total order of 100,000 United States Railroad Administration standard cars, 60,430 have been received from the builders prior to the same date.

Cotter Pin Hammer

By A. C. Clark, Pittsburgh, Pa.

The accompanying engraving shows a very handy hammer for handling cotter pins. It is forged in one piece, handle and head, and weighs about 1¼ pounds. It is a cheaply-made and handy tool. In making it, however, it would be a pleasanter tool to use if the section of the handle were to be forged of the usual section, instead of round, as shown in the engraving.

The face of the hammer is of the usual shape, the tail is curved and pointed and the end of the handle is made chisel-shaped. The uses of the three parts are as follows: The hammer face is to drive cotter pins into place and to close the split of the legs. The curved tail is to insert in the cotter pin to draw it, and the chisel end of the handle is to split the legs of the cotter.



DETAILS OF COTTER PIN HAMMER.

Distribution of German Locomotives and Cars.

Of the 5,000 locomotives turned over to the Allies by the Germans, according to the terms of the armistice, 2,600 were delivered to the French, 1,300 to the British, 600 to the Belgians and 500 to the Americans. The latter were turned over to the French, while the British quota were passed over to the Belgians. Of the 150,000 cars transferred from Germany to the Allies, 80,000 went to Belgium, and 70,000 to France.

New Locomotives for the Texas and Pacific Railway

The Texas & Pacific Ry. has recently received two groups of locomotives from the Baldwin Locomotive Works of the Pacific and Santa Fe types, that is, of the 4-6-2 and 2-10-2 classes. There were seven of the former and twelve of the latter, all being equipped to burn oil.

The Pacific engines have an extended wagon-top boiler with a comparatively low rise over the barrel. The firetube superheater is used and there is the usual American firebrick arch. The feed water is delivered by non-lifting injectors having a capacity of 4,200 gallons of water per hour with a steam pressure of 125 lbs. per sq. in. or 4,560 gallons when the pressure is raised to 200 lbs.

The front truck is of the Economy type with 33-in. wheels and the back truck has 51-in. wheels, it having been designed by the Commonwealth Steel Co., as was also the rear frame cradle. The main frames are 5 in. wide of cast steel of .40 carbon and were thoroughly annealed.

Walschaerts valve gear operated by type B Ragonnet reverse gear is used. The pistons are of rolled steel and the main and side rods are of vanadium steel.

The tractive effort of the engine at full stroke is 40,773 lbs. or a ratio of 1 to 4.25 of the computed adhesion weight.

The brake equipment is of the Westinghouse E. E. T. type and the drivers are braked to 60 per cent. of the loaded weight when there is a pressure of 50 lbs. per sq. in. in the brake cylinder, while a pressure of but 45 per cent. is used on the back truck with the same brake cylinder conditions.

A novelty, or perhaps an unusual feature of the equipment is the speed recorder that is attached to the rear truck.

PACIFIC 4-6-2 TYPE LOCOMOTIVE FOR THE TEXAS AND PACIFIC RAILWAY,
Baldwin Locomotive Works, Builders.

Two former groups of Santa Fe locomotives have been built for the road and these new engines follow them in design and, wherever it has been practicable, the parts are made interchangeable with them. The boiler is of the straight top type fitted with a superheater, a Gaines combustion chamber and a Security firebrick arch.

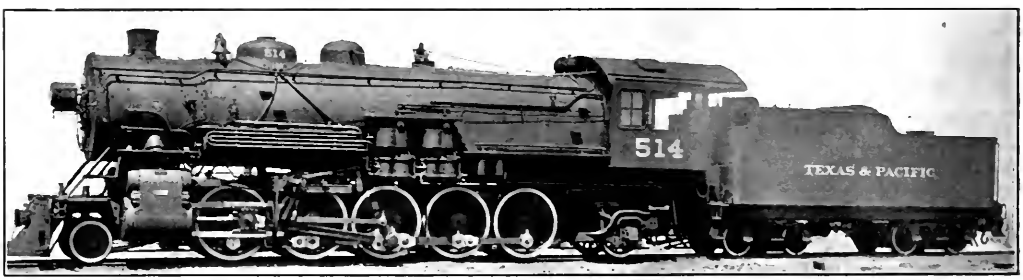
The two wheeled front truck is of the swing bolster type designed by the Baldwin Locomotive Works, and the trailing truck is of the Delta design used with the Commonwealth rear frame cradle.

In the engine also the Ragonnet reverse gear is used, but the Southern valve gear is installed instead of the Walschaerts. The pistons and brake equipment are the same as in the Pacific engines except that the driving wheels are braked to but 50 per cent. of the adhesion weight instead of 60.

The maximum tractive effort of the engines is 52,620 lbs. or a ratio of 1 to 4.23, or almost exactly the same as that of the Pacific locomotives.

The dome is set well forward at the center of the barrel which is so high that the bell had to be set on one side on the slope so as to obtain sufficient clearance. It will be noticed, too, that two compound air pumps are used.

The following is the list of the general dimensions of these two types of locomotives:



SANTA FE 2-10-2 TYPE LOCOMOTIVE FOR THE PACIFIC RAILWAY,
Baldwin Locomotive Works, Builders.

	Pacific.	Santa Fe.
Gauge	4 ft. 8½ in.	4 ft. 8½ in.
Cylinder	26 in. x 28 in.	28 in. x 32 in.
Valves—piston	14 in. diam.	14 in. diam.
Boiler—		
Type	Wagon-top	Straight
Diameter	74¼ in.	84 in.
Thickness of sheets	¾ in., 13/16 in., ⅞ in.	13/16 in. & ⅞ in.
Working pressure	185 lbs.	185 lbs.
Fuel	Oil	Oil.
Staying	Radial	Radial
Firebox—		
Material	Steel	Steel
Length	114⅛ in.	176½ in.
Width	75¼ in.	82 in.
Depth, front	82 in.	69½ in.
Depth, back	67½ in.	66 in.
Thickness of sheets, sides	⅜ in.	⅜ in.

	Pacific	Santa Fe
back	3/8 in.	3/8 in.
crown	3/8 in.	3/8 in.
tube	1/2 in.	1/2 in.
Water space—		
Front	5 in.	5 in.
Sides	5 in.	5 in.
Back	5 in.	5 in.
Tubes—		
Diameter	5 3/8 in. & 2 in.	5 3/8 in. & 2 in.
Material	Steel	Steel
Thickness	5 3/8 in., No. 9 W. G. 2 in. No. 11 W. G.	5 3/8 in., No. 9 W. G. 2 in. No. 11 W. G.
Number	5 3/8 in. 34; 2 in. 242	5 3/8 in. 41; 2 in. 267
Length	20 ft. 6 in.	18 ft. 0 in.
Heating surface—		
Firebox	216 sq. ft.	275 sq. ft.
Tubes	3,564 sq. ft.	3,539 sq. ft.
Firebrick tubes....		46 sq. ft.
Total	3,780 sq. ft.	3,860 sq. ft.
Superheater	844 sq. ft.	886 sq. ft.
Grate area	59.6 sq. ft.	70 sq. ft.
Driving wheels—		
Diameter, outside.	73 in.	63 in.
Diameter, center..	66 in.	56 in.
Journals, main...	12 in. x 22 in.	12 1/2 in. x 22 in.
Journals, others..	10 1/2 in. x 13 in.	9 1/2 in. x 13 in.
Engine truck wheels—		
Diameter, front...	33 in.	33 in.
Journals	6 1/2 in. x 12 in.	6 1/2 in. x 12 in.
Diameter, back ...	51 in.	42 in.
Journals	9 in. x 14 in.	7 1/2 in. x 12 in.
Wheel base—		
Driving	13 ft. 0 in.	21 ft. 10 in.
Rigid	13 ft. 0 in.	21 ft. 10 in.
Total engine	34 ft 7 in.	39 ft. 1 in.
Total engine and tender	71 ft. 5 3/4 in.	72 ft. 4 1/2 in.
Weight—		
On driving wheels.	173,360 lbs.	265,400 lbs.
On truck, front...	48,140 lbs.	27,800 lbs.
On truck, back...	53,580 lbs.	34,600 lbs.
Total engine ...	275,080 lbs.	327,800 lbs.
Total engine and tender, about....	450,000 lbs.	564,000 lbs.
Tender—		
Wheels, number...	8	8
Wheels, diameter.	33 in.	33 in.
Journals	6 in. x 11 in.	6 in. x 11 in.
Tank capacity, water	9,000 U. S. gals.	9,400 U. S. gals.
Tank capacity, oil.	3,200 U. S. gals.	3,100 U. S. gals.
Service	Heavy passenger	Heavy freight

Decrease in Accidents.

The United States Railroad Administration is reported to have been responsible for 569 fewer persons being killed during the first three months of 1919 than in the same period during 1918. The total number of accidents also were 9,709 less than during the opening three months of last year. If the same gratifying ratio of decrease is maintained throughout the calendar year, the Administration will have scored a signal victory for greater safety in the operation of railorads.

In this connection it is pleasing to record that the "No Accident Week" recently determined upon by the Chicago, Burlington & Quincy showed a reduction of 94 per cent over the corresponding week in 1918; that is, only 5 accidents occurred, as against 80, or one accident to every 121 miles. During the "No Accident Week" in 1919 there was one accident to every 550 miles. In regard to the ratio of employees injured there was an accident for every 671 men in 1918, and in 1919 there was one accident for every 3,270 men. Why not have 52 non-accident weeks?

Honesty and Government Service

By THE WANDERER

My stenographer who has had some experience in the world of business said to me the other day, "Why Mr. Wanderer you know that the government is the most dishonest corporation in the country." I couldn't say her nay because I felt that she was not only right but knew she was. And what is more, why shouldn't the government be dishonest? A chain is no stronger than its weakest link. A government bureau can be no more upright and honest than the men composing it, and what incentive is there for a man in government service to be honest? Oh I don't mean by a man being honest, not being a thief, because every government employe has every incentive in the world not to steal. But what incentive has he to be upright, and truthful and square with his fellow employes and the public? His position, his promotion, his standing with his employers depend upon making a showing. Of course and so does that of every worker in this broad land of ours of great opportunities. But there is a difference. The government bureau pays out everything but dividends. The great unthinking public must be cajoled and hoodwinked into believing that the head of the bureau is the greatest ever. The chief is a man of politics and political appointment and he must make his appointer believe that he is making good. So, if he has to do with inspectors, if he can give a statistical report showing that his men have made three times as many inspections as those of his predecessor at a cost of only twice as much, then his greatness is, at once, apparent to his superior and the dear public who never asks as to the quality of the inspection.

And the inspector? Well he must make a showing. And what is inspection for if not to detect defects? So the individual inspector must detect defects or lose his job. More than that he must detect more defects than his pal; otherwise, when there is a vacancy higher up, the pal gets the place. So it doesn't so much matter as to the real actuality of the defect or the danger that it may cause, provided it is reported and added to the list. This helps the individual inspector and helps to swell the greatness of the chief. In short every little bit of camouflaging that serves to cover a shortcoming or enhance a virtue receives the, perhaps unintentional, approval of every one above the camouflager.

Self-deception is said to be most dangerous. This is not self-deception. The bureau is without a soul except that it must please the public and Barnum was more than half right when he said that the public liked to be humbugged. So defects are glossed over and a great showing of economical operation is made by suppressing all overhead charges. No wonder the post office makes money. It pays no rental, no interest, nothing for new materials. That is all written off the books. The unsuspecting public has paid it all with no acknowledgment but a tax receipt and is lulled into a sweet belief in the greatness of the bureau head.

No! Government employes don't steal, or burn or loot, nor would I want to say they lie. They may even tell the truth and nothing but the truth but I am rather loath to believe that they tell the whole truth because of the stupendous inducements to hide a portion of it.

How would something like this sound in a locomotive inspector's report:

"I spent Tuesday inspecting locomotives in the round-house of the X. Y. Z. Railroad at Niceville. I found everything in applepie order and congratulated the round-house foreman and the master mechanic on the excellent state of affairs. Of course some defects were visible and for these I ordered two engines taken off the trains. One was for a frayed bellcord that was apt to break and the other was because the front window of the cab had not been washed recently."

Probably the first part of the report would be regarded as a superfluously rigid adherence to the truth and the dirty window defect be registered as a worthy cause of taking an engine from the train. And there is no exaggeration in that.

Private managers and men are differently situated. As engineers are the most truthful of men perhaps because they know that deception is sure of detection, so the managers of private industries must know and tell the truth. They cannot conceal overhead charges because they have to pay them. They cannot bury spoiled material because it has to be accounted for. They cannot send a salesman on the road and keep him there unless he produces results. They cannot jockey their books and tell stockholders they are making money unless they pay the dividends. They cannot increase wages indefinitely unless they also raise the prices of their output. They cannot be fed on words as to a plant's output unless the words are in the form of shipping receipts. In short they must be honest and truthful with their employers, because they are asked for accountings to the uttermost farthing.

So there it is. A government bureau has every incentive in the world to be dishonest and deceptive. A private management is driven to honesty and truth-

fulness as a matter of self preservation. Why then should private management be so much more efficient than government? Can it be that you are puzzled about it one little bit?

Mortality Among Metal Workers.

United States mortality statistics show that the percentage of deaths of males due to tuberculosis of the total mortality for certain occupations among metal workers is largest among those engaged as brass workers, being 31.8 per hundred, machinists, tinplate and other metal workers averaging about 19 per cent. Next to tuberculosis, heart disease is about 11 per cent. This includes all ages from 10 years and upwards. It will thus be seen that men engaged in these occupations have strong claims for liberal remuneration other than the high cost of living, which has its fluctuations, while the high death rate, under present conditions, seems constant.

A New Arabian Railway.

A railway from Aden, the principal port in Arabia, to Labej, the capital of the Abdali tribe in Southwestern Arabia, has recently been opened. It is 30 miles in length and was built by the British engineers, and the first four miles were built under shell fire from the Turks. It is now opened for passenger and freight traffic, and one train a day each way is operated and is well patronized. It is said to take the place of 500 camels. The civilizing effect of a railway upon the Arab tribes in the event of its extension will mark an epoch in the life of the nomads of the desert.

Auxiliary Reservoir Capacities.

Comparatively few people realize the great variety of brake cylinder sizes and arrangements that are in use upon American railroads. The standard stroke at which the brakes are intended to act is 8 in., but the cylinders have sufficient length to permit a 12 in. piston stroke. This variation in the length of the piston stroke makes a corresponding variation in the intensity of the initial brake cylinder pressure, it being lowered as the stroke is increased, and later modified by the amount of leakage. An examination of the tables that follow will show that the capacity of the reservoir is not always the same for the same size of brake cylinder when different forms of triple valve are used. In the case of the L. N. passenger car brake equipments the auxiliary reservoirs are so proportioned to the brake cylinders with which they are used that, with 70 lbs. brake pipe pressure, a reduction of 20 lbs. an equalized brake cylinder pressure of 50 lbs. is obtained with an 8-inch piston travel for tender and passenger car equipments and a 6-inch travel with engine truck brake equipments. This is what is also aimed at in the freight equipment.

This is probably a much wider range than most people, even those connected with the air brake service realize, and serves to illustrate the complications and complexities that have been developed in that branch of the service.

The auxiliary reservoir capacities for the several brake cylinders and services are as follows:

Place	Brake Cylinder Diam.	Auxiliary Reservoir Capacity.	Supplementary Reservoir Capacity.
Engine Truck	6 in.	890 cu. in.	
" "	8 in.	1221 cu. in.	
" "	10 in.	1809 cu. in.	
" "	12 in.	2450 cu. in.	
Driver	6 in.	1588 cu. in.	
"	8 in.	2125 cu. in.	
"	10 in.	3088 cu. in.	
"	12 in.	4476 cu. in.	
"	14 in.	5724 cu. in.	
"	16 in.	7436 cu. in.	
"	18 in.	8577 cu. in.	
Tender	8 in.	1588 cu. in.	
"	10 in.	2450 cu. in.	
"	12 in.	3088 cu. in.	
"	14 in.	4476 cu. in.	
"	16 in.	5724 cu. in.	
P. M. & L. N. Passenger	10 in.	2450 cu. in.	5724 cu. in.
" " " "	12 in.	3088 cu. in.	8577 cu. in.
" " " "	14 in.	4476 cu. in.	10158 cu. in.
" " " "	16 in.	5724 cu. in.	14003 cu. in.
" " " "	18 in.	7436 cu. in.	18967 cu. in.

Double Brake Cylinder.	Brake Cylinder Diam.	Auxiliary Reservoir Capacity.
P. M. Passenger	12 in.	3088 cu. in.
" "	14 in.	4476 cu. in.
" "	16 in.	5724 cu. in.
L. N. Passenger	12 in.	8577 cu. in.
" "	14 in.	10158 cu. in.
" "	16 in.	14003 cu. in.
" "	18 in.	18967 cu. in.
L. Triple Passenger	8 in.	2125 cu. in.
" " "	10 in.	3088 cu. in.
" " "	12 in.	4476 cu. in.
" " "	14 in.	5724 cu. in.
" " "	16 in.	7436 cu. in.
" " "	18 in.	10158 cu in.

U. C. Passenger Car Brake Equipment.

	Brake Cylinder Diam.	Reservoir Capacities. Auxiliary.	Service.	Emergency.
	14 in.	2592 cu. in.	3732 cu. in.	11290 cu. in.
	16 in.	2592 cu. in.	5080 cu. in.	13863 cu. in.
	18 in.	2592 cu. in.	6635 cu. in.	19085 cu. in.
2 cyls.	14 in.	3054 cu. in	8444 cu. in.	23857 cu. in.
"	16 in.	3732 cu. in.	9651 cu. in.	31686 cu. in.
"	18 in.	5080 cu. in.	11290 cu. in.	38170 cu. in.
Pennsylvania R. R. Standards.				
"	14 in.			14314 cu. in.
"	16 in.			17823 cu. in.
"	18 in.			21471 cu. in.

Freight Service.

Brake Cylinder Diameter.	Auxiliary Reservoir Capacity.
8 in.	1660 cu. in.
10 in.	2440 cu. in.

Steel Underframes for Repairs of Hopper Bottom and Caboose Cars

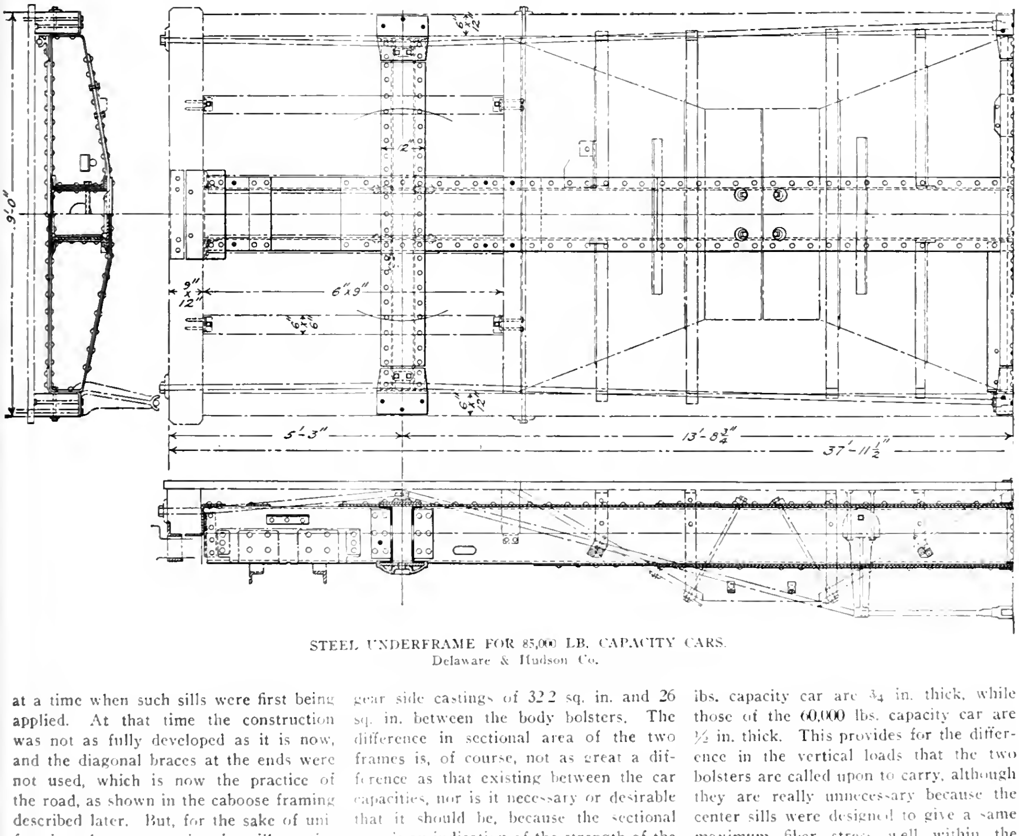
Like many other railroads, the Delaware & Hudson Company was faced a few years ago with a situation demanding immediate attention in that it had a number of wooden cars that, while they were otherwise in a sound and serviceable condition, had underframes that were too light to meet the requirements of present-day heavy trains. In order then to hold fast to that which was good and let go that which was bad a steel center sill and bolster was designed and has since that time been applied to these cars as they come in for repairs. It was designed at a time when such sills were first being applied. At that time the construction was not as fully developed as it is now, and the diagonal braces at the ends were not used, which is now the practice of the road, as shown in the caboose framing described later. But, for the sake of uniformity, the construction is still continued and the results of six years or more of service on some of the cars show no bad effects.

There are two classes of cars that are being treated in this way, namely, those of 60,000 lbs. and 85,000 lbs. capacity, respectively, both being hopper-bottom cars. The center sills are formed of two 15-in. channels weighing 33 lbs. per foot and spaced $12\frac{7}{8}$ in. apart between the webs for both the 60,000 lbs. and the 85,000 lbs. capacity cars, a cover plate 5-16 in. thick being used at the top and bottom of the channels of the 60,000 lbs. capacity cars and for the 85,000 lbs. cars there is one at the top 5-16 in. thick and two at the bottom, one $\frac{3}{8}$ in. and the other 5-16 in. thick. This gives a minimum cross section through the draft sills, between the body bolster and end sill, including draft gear side castings of 32.2 sq. in. and 26 sq. in. between the body bolsters. The difference in sectional area of the two frames is, of course, not as great a difference as that existing between the car capacities, nor is it necessary or desirable that it should be, because the sectional area is an indication of the strength of the center sill when acting as a column to resist the buffing stresses to which it is subjected in a train, and these are the same, regardless of the capacity of the car. This area coincides, as will be seen, almost exactly with the requirements of the minimum area of 24 sq. in. called for by the Master Car Builders' Association.

The difference in the vertical strength requirements of the two cars is made up by differences in the depth of drop of the truss rods. These are $1\frac{3}{8}$ in. in diameter in each case and they have a drop of 20 in. for 60,000 lbs. capacity cars and 32 in. for those of 85,000 lbs.

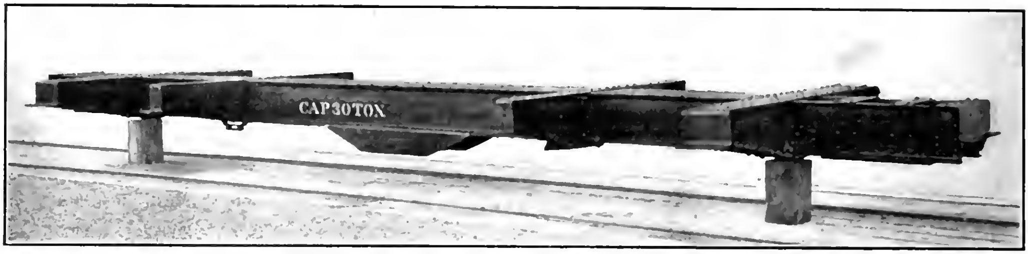
The bolsters are built into the framing and are formed of two pressed steel sections on each side. These have cover plates at the top and bottom. The top and bottom cover plates for the 85,000 lbs. capacity car are $\frac{3}{4}$ in. thick, while those of the 60,000 lbs. capacity car are $\frac{1}{2}$ in. thick. This provides for the difference in the vertical loads that the two bolsters are called upon to carry, although they are really unnecessary because the center sills were designed to give a same maximum fiber stress well within the limits of good practice without the aid of the truss rods, but it was considered more desirable to leave them on the cars rather than to turn them into scrap.

Carry brackets are located at the center of the 85,000 lbs. sill and two are located



STEEL UNDERFRAME FOR 85,000 LB. CAPACITY CARS.
Delaware & Hudson Co.

at distances from the bolster of one-fourth the distance between them. Each of these brackets, as well as the bolsters, are fitted with a step at each end to carry the wooden side sill, and this latter is strengthened by the framing of the car above it. The



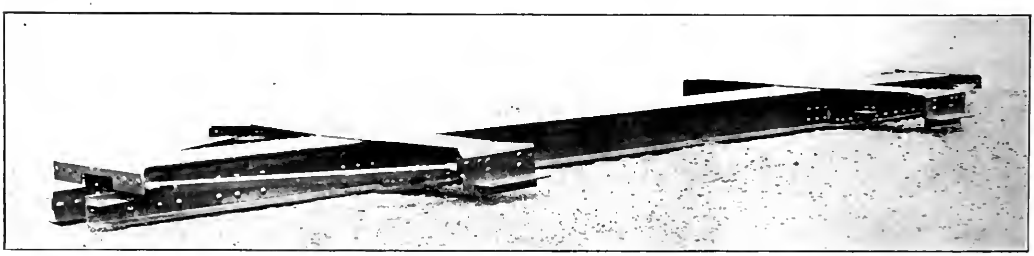
STEEL UNDERFRAME FOR 60,000 LB. CAPACITY CAR.
Delaware & Hudson Co.

reason for using one carry bracket for the 85,000 lbs. car and two for the 60,000 lbs. is that the former has two hoppers and the latter but one, and it was desirable to have one support for the sides, between

STEEL UNDERFRAME FOR 85,000 LB. CAPACITY CAR
Delaware & Hudson Co.

the hoppers, which brought it at the center of the car.

The bolsters are set 27 ft. 5½ in. apart from center to center for the 85,000 lbs. capacity car and the whole framing is 37 ft. 11½ in. long. The bolsters for the



STEEL UNDERFRAME FOR STANDARD CABOOSE.
Delaware & Hudson Co.

60,000 lbs. capacity cars are 23 ft. 10 in. between bolster centers and the frame is 34 ft. long over the end sills. This shorter length serves to stiffen the frame somewhat under the vertical loads as compared with the higher capacity cars and partially explains the necessity for a lesser drop of the truss rods.

The line engraving shows the construction of the frame for the 85,000 lbs. capacity car, and the reproductions of the photographs gives their general structurally substantial and symmetrical appearance.

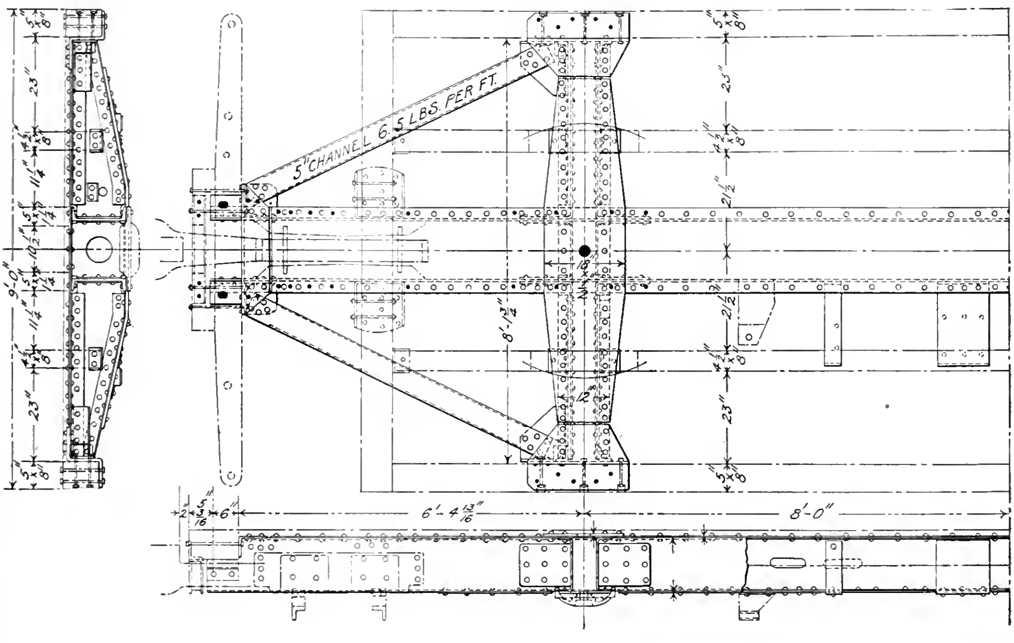
Frames of this same character are used under the caboose cars of the road, but they are of a somewhat lighter construction. The sills are made up of 12 in. channels weighing 30 lbs. to the foot, with a ¼ in. cover plate. This gives a sectional area through the sills of 23.4 sq. in., or a little below the M. C. B. requirements for cars. As a matter of fact, these sills are stronger in proportion to the work they have to do than are the car sills. The car sills are called upon to withstand not only the rough treatment of the yards, but the shocks due to the closing of the trains when brakes are released; while the caboose sills have simply to stand up against the pushing of the locomotives behind them.

It will be noticed from the line engraving and the reproduction of the photograph of the caboose frame that it has two diagonal braces at each end running from the end of the center sill to the outer end of the bolster. This serves to carry a part of the buffing stresses from the center of the car out to the end of the bolster, and thus distribute them through the car. This is considered by the designers a better method of locating these braces than to run them from the corners of the car to the connection of the center sills with the bolster, a matter that will be more fully discussed in another articles published at an early date.

It will also be seen that the caboose bolsters are given considerably more longitudinal strength in a line with the buffing stresses than the car bolsters. In the latter the cover plates are straight

from end to end and are 12 in. wide, while on the caboose they are 18 in. wide for the full width of the center sills and taper down to 12 in. at the end where they are strengthened by a substantial gusset plate and attachments for the diagonal braces referred to. Furthermore, these frames are comparatively short, being but 16 ft. between bolster centers and 30 ft. 8 in. long over the end sills. They are, therefore, of ample strength to sustain any buffing or compression stresses to which they might be subjected from ordinary train shocks or the action of pushing engines which may be behind them. As for the latter, this will probably reach its maximum on the Ararat Hill of the Pennsylvania division, which is 18 miles long, and where Mallet locomotives, developing a tractive effort of 120,000 lbs. when working simple, are used in pusher service.

The caboose underframes, unlike those of the coal cars, are made entirely of structural steel shapes, eliminating pressed shapes, requiring no die work, and thus making repairs more easy and avoiding the usual delay of waiting for pressed shapes from manufacturers.



STEEL UNDERFRAME FOR STANDARD CABOOSE.
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Loading Long Material.

Loading long material may be taken as a sort of generic term for the loading of all material that requires more space for stowing on a flat or open car than a single car apparently contains. The word "apparently" is used advisedly because in the loading of long material the seeming capacity of a car has often to be exceeded. It is not so many years since long material meant telegraph poles or sticks of similar length and nothing more. Then bridge girders were added, and these have been followed by all sorts and conditions of material from roof girders to automobiles. And now instead of a few simple rules for tying and bracing, we have elaborate instructions for spacing and bearing blocks, crosspieces, diagonals, stakes and everything else that enters into the safe handling of an unwieldy shipment. And unwieldy shipments have grown rapidly in bulk and number during the past few years.

The letter ballot recently sent out by the secretary of the Mechanical Section of the American Railroad Association brings this matter out very emphatically. The whole aim of the arrangements presented is to secure a maximum load with safety of transportation for the various commodities listed. The circular is one that should not be limited, in its circulation, to railroad officers, but should be distributed among large shippers and made accessible to the public generally, because it is full of suggestions to all who have problems of this sort presented to them.

For example, a method of loading flexible plates or bars on single cars is offered, where the single length of bar is not as long as the car, but is more than half as long. The method given permits of such an overlapping of the plate as to secure a full loading of the car and an even distribution of the weight on both trucks, and that without danger of shifting. And when the plates are longer than the car there are instructions for loading and holding on one car. Roof and bridge girders with all their blocking and fastening are shown and perhaps most novel and quite as interesting as any of the others is the tilting method of loading from three to five automobile trucks on a single flat car and the stowing of a similar shipment in a box car where the automobiles are loaded on their sides on blocks of wood.

The circular carries illustrations of horses, double deck construction, blocking and even the method of tying wheels fast to the floor after they have been similarly blocked. As it stands it is a notable example of the thoroughgoing methods that are followed by the association committees and it seems to cover every contingency that can arise. But, when we compare it with the early circulars on the same subject, and argue from past experience, it must probably be looked upon merely as a report of progress, but certainly of a progress that has been most notable and is well worthy of that degree of publication calculated to meet the growing requirements of railway men particularly and shippers generally.

Locomotive Fire-Box Repairs

By J. F. Springer

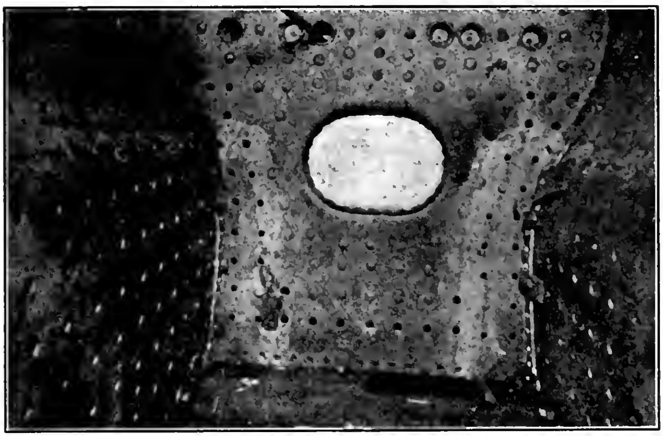
One of the most important uses to which it is possible to put the oxy-acetylene process in a railway shop is to the repair of locomotive fire-boxes.

First, there is the business of the removal of damaged steel. The oxy-acetylene cutting torch is a much more efficient instrument for cutting miscellaneous steel than is either the cold chisel or the hack saw. It operates with rapidity. It may be applied in any direction—up, down, horizontal. The thing that has to be looked out for is that the cutting jet shall have an outlet. The sparks must fly somewhere. They are not wanted on a rebound. Aside from this requirement, the cutting torch can do almost anything and operates almost anywhere. However, it cuts steel and not cast iron nor any of the non-ferrous metals.

If it is desired to patch a damaged location in the fire-box, the cutting torch may be used to cut out the piece. In general, it will be well to cut out a big enough piece and so make sure that all damaged metal has been removed. The opening is then filled in with a patch welded to the surrounding plate.

But, at a shop of one of the principal Canadian railways, the practice seems to have been such as to prefer putting in a quarter or a half side. The object in view is to get out of the region of the fire line. The patch is said to have a life of from 12 to 18 months, whereas a half or quarter side was regarded as competent to last as long as the fire-box itself.

Sometimes a lot of cracks will be noted round the staybolts. The bolts are to be removed and the holes "countersunk and welded up." This method has been found very successful. Corner patches are welded in by running the patch into the tube or back sheets, as the case may be, at the same time removing the flanges. If it is decided to do away with a number of tubes, plugs are welded in the holes, first countersinking the holes and having the plugs punched by a countersunk die, which gives the proper bevel for welding. A great deal of trouble was experienced when welding in the superheat flues and tubes, when this was first started, but after a little experience, much better success was arrived at. Some operators prefer the tubes belled and others prefer them beaded, some prefer the water in the boiler and others do not. The operators on the Grand Trunk Railway like the belled methods best and with the water in the boiler. This keeps the tube sheet from heating, especially round the smaller tube. Tubes are set with copper ferrules set back 1-32 in. and the flues are belled out 3-16 in. to 7-32 and the small tubes 3-16 in. The sheet is roughened all round the tubes and flues, and the oil is burnt off with the oxy-acetylene flame and tubes and flues welded in with electrode, using a 1/8 in. mild steel or Swedish iron. While the foregoing directions were doubtless penned with the electric process more or less in view, as is indicated by the use of the word "electrode," still it is to be regarded as a practical guide, when a gas torch is employed.



TWO HALF SIDE SHEETS, IN FIRE BOX, TWO PATCHES FROM MUD RING TO TOP OF DOOR, TWO CRACKS IN BOILER HEAD AND TWO CRACKS IN THROAT SHEET, ALL WELDED BY THE DAVIS-BOURNONVILLE PROCESS.

The same writer, apparently a superintendent or foreman, has some interesting remarks as to the economy of modern welding when applied to a broken locomotive frame. "In the not very distant past, a locomotive with a broken frame was due for a period of several days in the shops before they could strip down one side and remove the frame to the smith's shop, weld it, and perhaps have it machined and then replaced. Now, we drop the pair of wheels which may cover the break, cut out the crack with the cutting torch to the shape of a double V at an angle of 90 degrees, clean off the oxide caused by cutting, and weld up with the metal electrode, using soft steel or Swedish iron, a frame 4 by 5 ins. being cut and welded in under 14 hours, and it can be done in less time by having two operators on the frame at once."

At the Sayre Shops of the Lehigh Valley Railroad, it seems to be the practice to renew a locomotive fire-box without removing the boiler from the frame. The old fire-box is cut out and a new one put in place. The new box is put in in three sections. The joints and seams are welded up and the job is done. At these same shops, it is the practice to use the oxy-acetylene torch in renewing the worn portions of the collars on car axles and tender axles. This is a case where the torch is used to put on metal. The collar is built up to provide enough material for the collar itself and to allow for machining to size. Naturally, the built-up collars, as the work is left by the torch, is more or less rough and irregular in form. The turning lathe or other cutting tool is then used to machine to exact shape and size. If the effect of using the torch is to give an excess hardness to the metal, the end of the axle may be annealed so as to get the requisite condition for the lathe or other tool to do its work. In cases where rocker or tumbling shafts in locomotive valve gear devices become worn, the worn portions may be built up in excess of the size wanted and then machined or otherwise cut to exact size. If a locomotive crank pin is too small, it may be built up and then machined.

In annealing the steel for the purpose of getting a built-up part ready for machining, one or two facts are to be borne in mind. Annealing is a heating operation in reference to which the temperature of beginning and ending are of importance. The temperature of beginning should be below medium cherry red. It

doesn't matter how much below. The heating may be begun from the cold condition. The stopping point varies with the carbon content of the steel. For carbon percentages less than those of tool steels, the stopping point will be higher the less carbon there is present. If the carbon content is 0.90 per cent, then the annealing point is a little above 1274 degrees, F, that is, a little above medium cherry red. If the steel has practically no carbon in it, then the annealing point will be about 1675 degrees, F, that is an orange tending to a light orange. For intermediate percentages, the annealing points will be intermediate temperatures. These remarks as to annealing are useful, in as much as they serve as a caution against the idea that all that is necessary in annealing is to let the outer flame of the welding torch play over the work for a while. Annealing is not to be done in a careless or haphazard manner.

At one large railroad shop, where they had to deal with flues that had become pitted from the use of unsuitable water in the boiler, the oxy-acetylene process has been used to remedy the pitting. First, the flues are hammered round the locations of the pits with the view of getting rid of scale and dirt. Afterwards, the pit is treated by the oxy-acetylene process and the cavity filled up. We are not to understand, however, that flues which have been badly pitted are regarded as proper objects of repair. They are, in fact, scrapped. The pits are dealt with before the pitting has gone far—at least, that is the idea. It is said that the average cost of treatment is a trifle over one dollar per flue and that upwards of 6,000 are handled per year. Under the conditions on this road, the life of the flues is said to be about doubled by the treatment.

Bolsters are repaired by this road by means of gas welding. In one case, a bolster had been welded across, to repair a break. Later on, a second break occurred near the old one. But the new one was outside the old. The new break was cut out by the oxy-acetylene process and then welded up.

In dealing with fire-boxes, one of the most important difficulties relates to expansion and contraction. In one case a fire-box sheet had a crack which connected 9 stay-bolt holes. The effort was made to weld the crack. When it was done, an adjacent line of stay-bolt holes, 8 in number, were connected by a crack—undoubtedly a new crack which was created when the filling metal put into the old crack contracted as it cooled. When a V-groove is filled up with molten metal, we have a filling of expanded material. When the work cools off the highly heated filling contracts a very considerable amount because of the large number of degrees through which it cools. The crack itself will perhaps contract some; but it is to be remembered that the metal forming the walls and adjacent material of the crack has not been heated to the melting point or anywhere near it, except for a small amount of material. Consequently we can not ordinarily expect an excessive amount of contraction here. Apply this explanation to the fire-box sheet. After the crack connecting nine holes had been welded up, the filling material had to cool down through a big range of temperature. The sheet itself no doubt contracted some and reduced the crack somewhat. But in the present case one is to understand that the filling contracted more than the crevice was inclined to do. The result was a pull on the metal and a crack along the next row of stay bolt holes. In this case the welding up of the crack connecting eight holes resulted in the next row of holes being connected with a crack involving four holes. As the sheet already had a patch the prospects of going to the scrap pile were apparently pretty good. However, you can never tell. The oxy-acetylene process and similar procedures are pretty good in remedying bad situations. A piece of the sheet including all the cracks was cut out and a patch put in place. In order to prevent a repetition of making a new crack when filling up a seam, the fresh piece was forced in towards the water side along its center line. A suitable rig was arranged so as to force the new piece and thus bend it. The effect was to open up the crevices along the sides, that is, the joints between the side edges of the patch and the adjacent edges of the sheet itself. By filling in the enlarged grooves and then releasing the rig holding the patch to a bent condition, less opportunity is given for cracking. Presumably, the release is generally to be more or less gradual and to be carried out as the welding is completed.

Application Safety Devices to Locomotives.

Regional Director Bush's Order No. 221 addressed to federal managers and terminal managers of the Southwestern region:

For the promotion of safety, the following devices are approved for application to lomomotives on lines under federal control:

1. Locomotives should be equipped with water glass which may be observed by both the engineer and the fireman from their respective positions on the seat box. If it is necessary to meet this requirement, two water glasses should be applied.

2. Suitable cab heaters, where required on locomotives operated in the northern half of United States, which means roughly north of a line drawn from Washington through Cincinnati, St. Louis and Denver.

3. All locomotives should have boiler heads and steam pipes in cabs lagged during the hot weather period.

4. All locomotives equipped with electric headlights to be equipped with electric classification lights and with electric light or lights on the rear of the tender, as may be required by the rules.

5. Mechanically operated fire doors have proven to be one of the most valuable safety devices, therefore all locomotives passing through the shop for classified repairs will have mechanically operated fire doors applied. Such doors must meet the specifications for United States standard locomotives.

6. All air brakes cut out cocks in locomotive cabs to be standard size and type as provided by the standard of the air brake companies, and must be so located that they may be conveniently reached by the enginemen and so maintained that they may be readily operated.

Please issue instructions making the changes as rapidly as may be consistent with operation conditions. To the extent that the application of these devices involves a charge to capital account, authority is given to proceed with the work, even though the corporation owning the engines does not agree to assume the capital expense. Of course, the approval of the corporation to the capital expense should be secured, where possible.

Decline of Apprenticeships.

The decline and practical extinction of the apprenticeship system in the United States has devedoped a happy-go-lucky system of industrial training which, in many cases, is little better than no training at all and in all cases is enormously costly. Men steal trades by misrepresenting their experience when hiring to a new employer. They may claim to be machinists, toolmakers, carpenters or plumbers, and on the strength of false claims be hired and put to work. But it soon becomes apparent to a watchful foreman that such a man is a fraud and that he knows very little about the trade in which he claims to be proficient. The labor conditions, however, are often such that the workman is necessarily kept a while to tide over an emergency, and then he is discharged to go on his way to repeat the performance. A few experiences like this will make the trade stealer familiar with the general conditions of the trade, and if he is bright he may, in time, become fairly proficient, and able to hold a job. But at what a price? He has cost the concerns that employed him hundreds, or perhaps thousands of dollars and has lived a dog's life—filled with apprehension and hating himself for the deceit that he must practice.—*Report to Acetylene Association.*

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Consideration in Wage Demands.

Just after the war started and when the whole civilized world, individually and collectively, was making unheard of sacrifices that our civilization might be preserved, the optimists put forth the propaganda that the struggle would result in the purifying of all men. That, hereafter, there would be a feeling of brotherhood abroad, that altruistic ideas and principles would prevail and that a man's ideal of life would be the good that he could do rather than the goods he could garner into his barns. But there were enough outcroppings of the old Adam in the way of profiteering and wage grabbing to show that the visions of the optimists were visions and not much more.

Now that peace has come there is no peace. Half the world is still fighting the other half, and, to put it Hibernically, the rest are fighting among themselves. Of this, however, all men are agreed, and that is, that so long as this wrangling continues industrial, commercial and agricultural prosperity is an impossibility. It is also fair to assume that that property is what every man wants. Hence in order to obtain it, it behooves all interested parties, labor organizations as well as aggregations of capital, to look to the other fellow's standpoint and sacrifice a little of present possibilities to grab to the assurance of future welfare not only of themselves but of the rest of the world.

We have stood aghast at the insolent looting of Belgium by the Germans. Their utter disregard of the rights of others and their own obligations to themselves and the world as human beings. We fought to overthrow their creed that "might makes right," and then come home to make a lurid exemplification of the same sort of policy, except that instead of looting our enemies we turn against our friends and neighbors and fellow citizens. The prime question at the Paris conference was not so much as to what Germany ought to pay, but what she could pay and survive. So now it is well for those who are formulating the demands of organized labor to keep this same thing before them. Not what they think the public ought to pay them for their services, but what the public can pay and remain solvent. Men who have worked for bankrupt railroads, especially in the old days, have had lessons in the joylessness of being paid in depreciated script. And demands made upon the railroads today, railroads that are piling up unheard of deficits, are such as to bankrupt a nation. Someone must pay the bills, for the two sides of the account must balance, and when there is a revolt against taxes and government burdens even the forced wages extorted by those in power will fade away and the gains of practical loot will be lost. For these reasons then, reasons that are no more than enlightened self-interest, it is well for organized labor to look carefully to its demands lest it over-reach itself and ruin its own prospects of future betterment, and set back the possibility of our national prosperity for many years.

Mechanical Stokers and Economy.

For many years, in all of the discussions before the Master Mechanics' Association, the excessive use of coal by mechanical stokers, as compared with hand firing, has been one of the points brought forward against the device. It has been explained that the novelty of the method, the ease with which the work could be done and the prime necessity of keeping the engine hot at any cost was the reason for all of this excess.

But now the stoker has earned its spurs and needs no advocate as to its utility, it still continues to burn more coal than its hand-fired competitor, but it does more work.

A critical study of the situation was recently presented to the Western Railway Club by Mr. W. S. Bartholemew, the president of the Locomotive Stoker Co., in which the actual commercial economy of the mechanical stoker as opposed to its apparent excessive coal consumption was well set forth.

Of course it is well known that the more rapid the rate of combustion per square foot of grate area the lower the rate of evaporation per pound of coal. This holds for any type of firing, hand or mechanical; and an interesting feature of the case is that for low rates of combustion the evaporation per pound of coal is less with mechanical stoking than with hand, while for high rates of combustion the two stand about on a par. In other words, we find that the old statement holds that nothing can equal skillful hand firing for economy when the rate of combustion is low, but that skillful firing is not equal to the strain of feeding 8,000 or 9,000 lbs. of dry coal per hour into the firebox of a locomotive and doing it economically, and when greater demands are made the man fails because of inability to meet the physical requirements to do the work. This, then, puts a limitation on size of locomotives and weight of trains when hand-firing is used.

Now coal consumption per hour and coal consumption per mile are two very different things. The consumption per hour may be much greater on one engine than on another, while that per mile may be the same or less, because of the greater speed made by the former. In fact a test cited showed this to be the case where the stoker engine covered a division in seven hours, as against eleven by the same engine hand-fired. So that the first engine could have been turned, coaled, watered, repaired and well on its way on a return trip at the time of the arrival of the hand-fired machine. From a traffic standpoint there could be no discussion as to the comparative value of two such locomotives.

But the matter cannot be left there. It has been the universal experience from time out of mind, that the moment a locomotive has demonstrated its ability to equal or exceed the work for which it was designed, greater loads are given it to haul, and these are steadily increased until its final capacity has been reached. And so it was with the engine whose test has just been outlined. The loading was increased until it was found that the stoker-fired locomotive, by hauling the heavier tonnage, would actually pay for itself in less than a hundred trips by its increased earnings over its hand-fired rival. And this has been the experience in many other places. For example: on some tests made on the Atchison, Topeka & Santa Fe the coal consumed per hour ranged from 1,000 to 2,000 lbs. more than on the hand-fired, yet the average per 1,000 ton-miles was almost the same as that of the hand-fired, while the tonnage hauled averaged 300 tons more and the time about 45 minutes less. Certainly the extra coal per hour was very profitably burned.

This matter of speed increase made possible by the stoker is most important upon long grades where there is a heavy

drag upon the engine and it is taxed to the limits of its possibilities, and this taxation is apt to go beyond the limits of the fireman to handle coal. Here the stoker does not tire and its capacity to meet requirements is limited only by its design.

To repeat what has already been alluded to, the efficiency of the boiler falls off as the rate of combustion per square foot of grate increases. But while this efficiency falls the amount of coal per ton-mile also falls, to the advantage of the economical operation of the locomotive as a whole, and this is what should be aimed at. Hence it appears that the mechanical stoker of to-day has not only passed beyond the experimental stage insofar as its mechanism and ability to maintain steam pressure is concerned, but has also passed beyond that stage insofar that it has become an important factor in the economical operation of our railroads.

The Need of an Automatic Train Stop.

Human fallibility crops up again and again on the railroads, and while the recent collision at Port Chester, N. Y., was not largely fatal because it occurred between freight trains and only two men were killed, the investigation clearly showed that the engineer ran past the visual danger signal at the entrance to the block. The wrecked engine showed that the throttle valve was still open, which supports the theory that the dead driver was either asleep or unconscious through illness, but the discouraging fact to the travelling public is that there was no automatic train stop device provided to prevent the engine from running past the stop signal. The New York Public Service Commission of the Second District is our authority for the statement that there are such devices now in use on one or two short lines which have undergone successful service tests, not speaking of the automatic stop system established in the subways of the Interborough Railroad in New York City, which may be said to be placed in ideal conditions, entirely free from climatic or other disturbing conditions, and which, while functioning admirably under repeated experiments, has never, so far as we are aware, been tested by the lapse of a sleeping or unconscious motorman. These men, depending on the signals, have never failed to control their trains, in spite of the fact that the amount of passenger traffic at certain hours has no parallel in the world.

It is noteworthy that in ninety-two railway accidents investigated by the Interstate Commerce Commission Safety Department, it was found that sixty-nine of them, causing 233 deaths and 1,068 injuries, were in the class known as preventable by an automatic train stop, designed to halt the train if by any chance the engine driver should run past a stop signal. In this connection it may be remembered that previous to the war it was proposed to establish an experimental station in Illinois, where all recommended devices looking towards greater safety on the railroads, would be tested under Governmental authority by expert engineers. We were hopeful that something would come of it, but, as usual, no appropriation was made by Congress. True, during the war an expert commission was established in Washington, but the war-cloud diverted its attention to engines of destruction instead of safety.

Various scattered reports have shown that a high degree of perfection has been attained in automatic stops that would justify the Government and the railroads in making an extensive and thorough trial of them, and the Interstate Commission has favorably reported some of these inventions to Congress for action, and our legislators would have been justified in making a serious effort to furnish opportunities to sort out the best inventions and apply them in the solution of this life-saving problem.

It seems that it requires individual or corporate enterprise to establish any marked advance, as in the case of the air brake and the automatic coupler, both enforced by acts of Congress after the devices had compelled popular approval. It would seem that so-called statesmanship rather retards than encourages invention. It is strange that in a country of unparalleled wealth and in a commercial age there is never any money to pay for the crying needs of the hour. America is not alone in this regard. Every civilized country is staggering under a load of debt. And so it has been all through the ages with the shining exception of Athens in the age of Pericles, who managed somehow to fill the Parthenon with solid gold, so that the Polopenessian war was carried on for eight years without taxing the martial Athenians in their struggle against the Spartans. History, in this case, has not repeated itself, nor is it likely to do so until nature produces another Pericles.

European Coal Shortage.

It is probable that the United States will be called upon, for some time to come, to assist in the relief of the coal shortage of Europe. Before the last great allied drive and while the Germans were at the height of their victorious advance, the feeling prevailed in many sections that, with Lens once back in the hands of the French, and the northern coal fields opened to allied operation the situation would be relieved. It was hard to believe, even of the Germans, that they would deliberately so destroy the mines as to render them useless for years to come, and so it was expected that the French deficit would be soon relieved.

This expectation was wiped away when the condition in which the vandals had left the mines was learned. These mines had a production of some 20,000,000 tons a year before the war. To this home production England added more than 30,000,000 tons. With the decreased output of the English mines and the elimination of the whole output of the French, it seems probable that there will be a call on the United States and such other sources of supply as may be available to make up a deficit of 50,000,000 tons, more or less.

The Germans, confident of their success, and bent on the annexation of Belgium, did little or no damage to the mines of the country which they expected to retain. But while the mines are uninjured the task of resuming operations under present conditions of labor and reconstruction will make the process a slow one, and it will undoubtedly be some length of time before the full output is again reached. And even when it has been reached the cost of production will be greatly enhanced. It is estimated that this will be from 75 to 125 per cent. more than it was during the last year before the war.

An estimate has been published showing the amount of coal that was supplied to the countries of Europe by Great Britain before the war, and the total amounts to about 50,000,000 tons annually. If to this be added the 20,000,000 tons output of the mines of northern France, we have a possible call of 70,000,000 tons to be imported into Europe to meet the pre-war demands that were made on England alone. This is a demand that is evidently far above the possibilities of the English mines, with their decreased output, to supply, and the only other available source would seem to be the United States.

With the possibility of a decrease in production here, the outlook is not a pleasant one for the coal supply of the world for the immediate future. From the statements of a British commission it looks as though the demand on American coal for export to Europe would be about 40,000,000 tons, and this can probably only be met by strict economy at home and the full working of the mines of the country.

Women Employed by the Railroads.

The total number of women employed under the United States Railroad Administration reached the highwater mark on October 1, 1918. At that time there were on the rolls 101,785 female employes. The number of women employed on April 1, 1919, showed a de-

crease of 14.3 per cent. as compared with January 1, 1919. On January 1 of the present year there were on the rolls of the railroads 99,694 women employes, while on April 1 the number had dropped to 85,393.

The clerical or semi-cler cal occupations, including all the office-workers, ticket sellers and telephone switchboard operators constituted the largest percentage of the total for the year 1918, being seventy-two per cent. The statistics show that more than 5,000 women worked in railroad shops and more than 1,000 in roundhouses. The latter included among others turntable operators and engine wipers. On October 1, 1919, there were six women employed as blacksmiths, helpers and apprentices, while a large number of others worked as boilermakers, coppersmiths, electricians and machinists. There were 377 women employed as station agents, assistants and agent operators on the same date, while fifty were at work as switch tenders. There were 931 women pushing trucks and handling freight. Watchwomen to the number of 518 were employed on the railroads doing duty both day and night.

Acetylene in Transportation.

Col. B. W. Dunn, of the Bureau of Explosives of the American Railroad Association, delivered an address on Acetylene Transportation before the International Acetylene Association at its recent convention. Referring to the feeling that it is the other fellow's carelessness that causes all the damage, he said:

I found, when I assumed charge of the then newly formed bureau, and was talking to the manufacturers of dynamite, I could only refer to my fears as to what might happen in the transportation of this product, because my office had no data of what actually had happened, the dynamite men buttonholed me in the corner of a room and assured me that, confidentially, I was on the right track in looking out for these transportation risks, but I would find all the dangers in the case of the man who made black powder, and the man who made dynamite was all right. In due course, when I met the black powder man, he buttonholed me and assured me to the contrary, that all the risks were with the dynamite man.

It seemed to me highly desirable, if not necessary, at that time, because of my early experiences, that my office should accumulate some facts, so that when anyone seemed to be disposed to underrate the risks that naturally attached to the product they were shipping, that I should be able to show him some figures.

That was started, and at the present time, in practically all classes of dangerous articles, there is a compilation now kept in my office to show what has been reported to us in regard to the accidents and troubles that have occurred in handling that particular product.

We have had reported to us with regard to accidents in manufacture requiring the use of acetylene gas a total of 39 accidents, causing the death of 16 persons and injuries to 45 persons.

With regard to accidents in the manufacture (compression, generating or charging) we have had 27 accidents reported, causing the deaths of 26 persons and injuries to 55 persons.

In connection with the storage of acetylene, we have had six accidents reported, causing the death of one person and injuries to 14 persons.

In connection with miscellaneous accidents, accidents in handling, and similar accidents, we have had 5 accidents causing the death of one person and injuries to 4 persons.

This covers the period of twelve years since the organization of the bureau. The number of accidents in the transportation of compressed acetylene gas reported to our bureau in that time was 24, in which one person was killed and there were 17 persons injured. It is gratifying to know that the accidents in transportation are relatively small in number and not very disastrous in result.

Now, as to how can it be made better in the future. My experience of twelve years in this field teaches me that one way to make trasportation hazards better is to secure the enforcement of well-designed standardized methods of manufacture and packing and handling in transit of the products that you manufacture.

When this work was started there was no standardization, no rules, no uniform practice, and it is not surprising that the transportation interests of the country suffered largely through handling such materials as dynamite and high explosives. In fact, the first year of our work, 1907, the first year that we attempted to seek any data, showed, as I recall the figures, something like 54 persons killed and 80-odd persons injured by explosions that occurred on railroad property, and about half a million dollars' worth of property destroyed.

During the year 1918, there were not less than 50,000 cars on the railroad tracks of the United States, somewhere practically every day, bearing high explosives, which were required for the service of the government—in spite of all that large volume, there was not a single person killed in the United States as the result of the transportation of explosives.

When it comes to acetylene we have this trouble: You know, as well as I do, that the potential danger in regard to it looms large. There are many things that might happen if certain things are not done; and to the railroad man, those things that might happen, in spite of anything he can do, are the ones that impress him most. It is the "concealed hazards" which cause him the most concern. The railroad man, for example, hates the mention, even, of an article that is subject to spontaneous combustion, simply because in spite of all his care he may find his car on fire, and the car may be on fire next to another car containing a dangerous inflammable product, so a conflagration may follow.

The point to be insisted upon and followed to a finish is the standardization of the method of manufacturing and preparing the containers. And even the best of you will have a good deal of weeding out to do in relation to old containers before a standardization can become effective.

The New Specifications for Material

Specifications for material have been submitted to letter ballot for adoption by both the Master Mechanic and Master Car Builder divisions of the Mechanical Section of the American Railway Association. In general they develop a more elaborate specification than the previous one. Tables are elaborated and inspection tests added that did not exist before. For example, in the old specifications for rivets the diameter of the rods were given with the permissible variations over a range from ¼ in. to 1¼ in. in diameter. In the new, the table covers the diameters and thicknesses of the heads for the cone, button, steeple and countersunk shapes over a range of diameters from ¼ in. to 2 in., advancing by increments of 1/16 in. up to 1¼ in., then by ⅛ in. to 1½ in.; afterwards by ¼ in. Some minor matters are eliminated and many items amplified, as in the case of air brake hose gaskets, where several paragraphs on their manufacture, physical properties and tests are added, together with a complete set of dimensions, which was lacking before.

In the M. C. B. section, one of the notable additions is that of provision for annealing lugs to be cast on carbon steel castings for freight and passenger equipment cars. These additions provide for annealing lugs to be "cast on all castings 150 pounds or over, and on such castings less than 150 pounds as required by the purchaser." Provision is also made for group melting. That is, after 15 consecutive melts have been made and the castings therefrom inspected and accepted, the manufacturer may group the succeeding melts in lots of five melts each, but each lot not to exceed 40 tons.

The changes are all in a line with improving the output and reducing the chances of dispute between maker and buyer, and it is probable that all of the recommendations that have been made will be adopted.

Air Brake Department

The New Rules for Air Brake Inspection—Questions and Answers

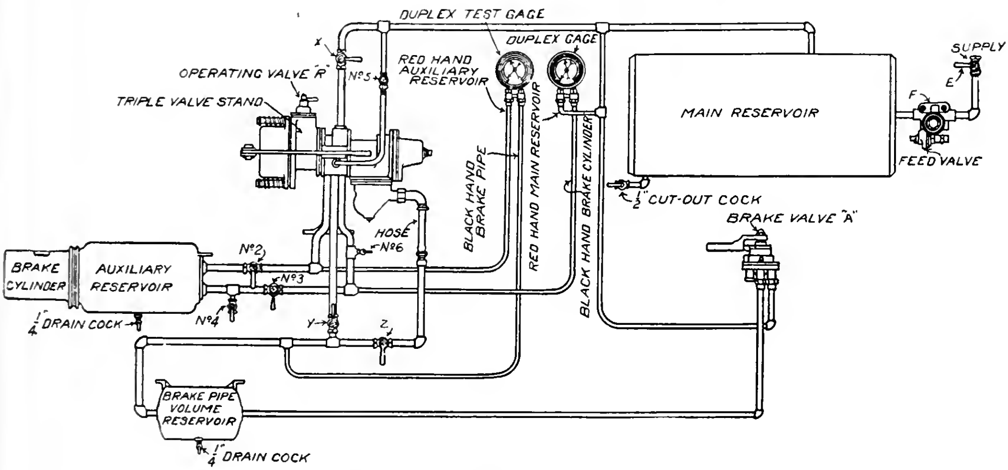
In the revised form of rules and instructions for the maintenance of freight brakes that has been submitted to the letter ballot of the mechanical section of American Railroad Association, there is a very evident appreciation of the necessity for more thorough work than has been performed in the past, and there are some important additions to the rules as a consequence. It is possible that some of these rules may be difficult to enforce and will be more honored in the breach than in the observance. Take the rule for incoming trains as an example. Here it is required that they shall have the "slack stretched and left with the brakes fully applied in service application." This is a simple thing, but difficult to enforce, especially as the necessity therefor is not immediately apparent.

As the present rules do not include anything for the, testing and repair of brakes in terminal yards, the addition of such rules is a matter of great importance. These new rules cover a general inspection of all parts of the brake apparatus, and then after a 15 pound service reduction a second examination for brake pipe leakage, triple valve operation, piston travel, brake cylinder leakage, and brake release, with the reduction of brake pipe leakage to from 5 to 8 pounds per minute, if it is more than that, and the adjustment of piston travel to from 6 to 8 in.

At the present time there is no provision for the inspection or testing of cars on the repair track, provided such an inspection is not due according to the date stenciled on the apparatus. In short, there are no "in date" inspection requirements. The new rules practically require as complete an inspection of the air brake apparatus on all cars on repair tracks with the stencils "in date." as though they were "out of date." In short, annual inspection, if not repairs, must be given to the air brake apparatus for every car on the repair tracks.

The rules for annual repairs have also been elaborated in almost every case, and many mandatory phrases inserted. For example: The present rules state that "the triple valve *should* be removed from the car for cleaning." The new rules state that "the triple valve *shall* be removed from the car for cleaning," etc.

Finally, the committee have formulated a set of rules for tests to be made on the No. 2 test rack, for which there are none at present. The general assembly appearance of this No. 2 rack is shown in the accompanying engraving, and the tests that it is proposed to make upon it are: A resistance test for the determination of the resistance to motion of the piston and slide valve; a charging test for triple valves, that is, the time required to charge the auxiliary reservoirs from 0 to 70 pounds, both with new and repaired valves and those that have merely been cleaned, a table being given, within the range of whose figures the work must be done; a leakage test to determine whether there is any leakage past the triple slide valve, this being done in emergency, release and service lap position; a release test to determine the time required to move the triple to release position, which should not exceed 4 seconds for the K-1, K-2, H-1 and F-1-B valves, or 3 seconds for the H-2 and H-1-B valves; this to be supplemented by a retarded release test for the K triple; a quick service port test for K triples to insure a drop of 5 pounds in the brake pipe in not more than 4 seconds; a leakage test for the packing rings of triple valves; a stability test to insure that the triple valve will not go to emergency before the triple brake pipe pressure has been reduced 20 pounds; an emergency test to insure that the valve will go to emergency before the brake pipe pressure has dropped 20 pounds.



ASSEMBLY DIAGRAM—TRIPLE VALVE TEST RACK.

This is an outline of some of the more important of the changes that are suggested for the inspecting and testing of the air brake, indicating the necessities that have arisen because of the severe conditions of train handling that are now imposed.

It will thus be readily seen that the new rules regarding the inspection and the new devices provided together form a marked improvement in the important phase of a continued high degree of efficiency in the details of the air brake.

Questions and Answers

Locomotive Air Brake Inspection.

(*Continued from page 244, August, 1919.*)

883. Q.—What should be done to a governor before any repairs are made in the shop?

A.—It should be thoroughly cleaned in a lye vat.

884. Q.—What care must be taken in dismantling for repairs?

A.—Extreme care must be taken to see that the cylinder is not damaged by mashing in a vise or by using a wrench that does not fit.

885. Q.—What are the most essential considerations in fitting up the steam valve portion of a governor?

A.—A straight, or perfect, cylinder, a governor piston that fits the cylinder and a packing ring that fits the groove of the piston as well as the cylinder.

886. Q.—Is there any other fit of importance?

A.—The steam valve should fit neatly where it passes through the governor cylinder.

887. Q.—What will be the result of a poor fit or a worn steam valve stem?

A.—A very bad leak at the governor waste port at the time the steam valve moves to close off the flow of steam to the pump.

888. Q.—Does the steam valve make a tight joint at any other point except at its bearing on the seat?

A.—Yes, the back of the steam valve must be ground to a bearing against the governor cylinder.

889. Q.—What is the effect of a leak at this point?

A.—A leak from the waste port of the governor at all times when the pump throttle is open.

890. Q.—And the effect of the leak at the waste port?

A.—Tends to drain oil away from the steam pipe and cause the compressor to run dry and stop.

891. Q.—How should a packing ring be fitted in the steam valve cylinder?

A.—The ring will, of course, be a trifle larger than the bore of the cylinder, so that the ends will lap over when placed in the cylinder, the ends must then be filed just sufficiently to lap over a trifle at the ends and make a joint at the ends. The object is to have the ring go through the cylinder with some friction when placed in the piston after which it must be ground until the piston and ring work freely through the cylinder.

892. Q.—How is a fit of the piston in governor cylinders maintained?

A.—By reboring cylinders and fitting larger than standard pistons, or by reboring and bushing the cylinder to standard size.

893. Q.—How is the fit of the steam valve stem maintained?

A.—By reaming the cylinder opening to a larger size and applying a steam valve with a larger diameter of stem.

894. Q.—Where may such steam valves be obtained?

A.—From the Air Brake Companies, who list the various sizes in their catalogues.

895. Q.—What port must be drilled in a bushing after a cylinder body has been rebushed?

A.—The one leading to the waste pipe.

896. Q.—What effect would this have if neglected?

A.—The same as a stopped up waste pipe; the governor could not stop the compressor.

897. Q.—How is the steam valve seat trued up?

A.—By the use of a special reamer made for this purpose.

898. Q.—After being repaired what test must be made?

A.—One to determine the amount of packing ring leakage.

899. Q.—How is it done?

A.—By connecting a line of air pressure to the opening through the cylinder cap and observing the amount that escaped from the waste pipe port.

900. Q.—What kind of a thread is in the cylinder cap?

A.—½ in. standard pipe thread.

901. Q.—What else is to be observed?

A.—That the governor piston returns promptly and opens the steam valve when the air pressure is shut off, and that the steam valve stem touches the seat when the piston travels downward.

902. Q.—How is the latter determined?

A.—By placing a shred of thin paper between the valve and seat and noting that the valve clamps it when forced toward its seat.

903. Q.—What is the cause of failures of a great many repaired governors?

A.—Attempting to fit packing rings in worn bushings.

904. Q.—What causes the pistons to stick in the cylinders after repairs are made?

A.—A shoulder is left in the cylinder, facing off the steam valve seat and possibly the steam valve also allows the piston to travel further than previously and the governor piston sticks in the shoulder formed before overhauling.

905. Q.—How many sizes of steam valve portions are in general use?

A.—Three. 1 in., 1¼ in. and 1½ in.

906. Q.—How do these sizes originate?

A.—From the cross section of the steam valve seat or from the size of the air compressor steam pipe.

907. Q.—What size of compressor is the 1 in. governor used with?

A.—The 9½ in.

908. Q.—The 1¼ in. governor?

A.—With the 11 in., the 8½ in. or two 9½ in.

909. Q.—The 1½ in. governor?

A.—With two 11-1 in. or two 8½ in. compressors.

910. Q.—What is to be particularly observed in connection with repairs to the regulating or diaphragm portions?

A.—That the diaphragm valve has a perfect bearing on its seat, and is of the correct length, and that the valve is not too rigid.

911. Q.—How could a valve become too short?

A.—By facing or grinding off the end of the valve in securing a bearing surface on the seat.

912. Q.—What is the effect of using a diaphragm valve that is a trifle too short or if it is too neat a fit through the diaphragm nut?

A.—It will not seat accurately at all times, and the governor will not be sufficiently sensitive in operation.

913. Q.—Is the same thing true of the excess pressure top?

A.—Yes.

914. Q.—How sensitive should a governor be in operation?

A.—It should not permit of a variation of over two lbs. in main reservoir pressure if it is in good condition.

915. Q.—What important point in fit must be observed, especially with the excess pressure top?

A.—The fit of the diaphragm body 'n the spring box.

916. Q.—Is this generally found to be too loose or too tight?

A.—It is generally found to be too tight.

917. Q.—What is the effect?

A.—The governor holds the compressor shut down at times through the diaphragm sticking in the spring box

918. Q.—What is to be observed in connection with the diaphragms?

A.—That they are not buckled.

919. Q.—What is meant by this expression "buckled"?

A.—That the surfaces are uneven, that the diaphragms are not perfectly flat.

920. Q.—How does this affect the operation of the governor?

A.—It renders it less sensitive, and frequently causes a very wide variation in the main reservoir pressure.

921. Q.—How are the regulating portions tested?

A.—By attaching an air connection, and with an air pressure that is constant, the tension on the spring should be increased until equal with the air pressure.

922. Q.—About how much movement of the regulating nut should then open and close the diaphragm valve?

A.—It should open enough to give a pretty strong discharge of air and then close off tight on about one quarter of a turn of the regulating nut.

(*To be continued*)

Train Handling.

(*Continued from page* 245, *August,* 1919.)

937. Q.—If broken below the cut out cock in the brake pipe?

A.—The brake pipe leak would be plugged and the stop cock closed and the valve handle carried in running position.

938. Q.—And if above the cut out cock?

A.—The stop cock would be closed to prevent air coming out of the brake pipe, and the handle would be carried on lap position instead of going to the trouble of plugging pipe merely for the purpose of carrying the valve handle in running position.

939. Q.—How would the brakes be applied with the independent valve if the automatic valve is in running position?

A.—By moving the independent valve to running position.

940. Q.—And with the automatic valve on lap position?

A.—By moving the independent valve handle to release position.

941. Q.—In either event?

A.—Allowing air pressure to escape from the brake pipe through the equalizing portion of the distributing valve.

942. Q.—Is there any other way in which air from the main reservoir could be admitted to the brake pipe in case of a broken brake pipe or reservoir pipe near the automatic brake valve?

A.—It may be done by removing the check valve from the dead engine fixture, but on account of the small ⅛ in. choke it is not recommended.

943. Q.—Why not?

A.—On account of not being able to deliver a sufficient volume for a prompt release or recharge of brake after an application.

944. Q.—What would be done in case of a broken reservoir pipe at the automatic brake valve, if the feed valve was detached from the brake valve?

A.—Both ends of the break would be plugged and running position of the brake valve used for a release and recharge of breaks.

945. Q.—And if the feed valve pipe was broken off?

A.—The feed valve adjusting nut would be screwed out to prevent a leak from one end of the pipe and the other end would be plugged.

946. Q.—And the brake valve handle would be carried?

A.—In release position.

947. Q.—What if the compressors would shut down and fail to start?

A.—It would indicate that there was no pressure above the diaphragms of the excess pressure governor top.

948. Q.—How would it be obtained if the excess pressure pipe was connected with the broken piece of pipe attached to the brake valve.

A.—By carrying the automatic brake valve at a point between release and running position in which air would be supplied to the feed valve pipe.

949. Q.—What if the engine and tender brake persisted in "creeping on" with the brake valve handle in release position?

A.—A leak could be started in the release pipe branch between the brake valves which would prevent this.

950. Q.—What could be done in the event of a broken air pump discharge pipe or connecting pipe?

A.—If connections cannot be made with two 1¼ in. brake hose, it means that the train must proceed without an air brake or that another engine must be secured.

951. Q.—With a feed valve in good condition, can the engineer tell when the valve is in operation, supplying the brake pipe?

A.—Yes, by the humming noise made by the supply valve piston traveling through the bushing.

952. Q.—Sometimes the valve makes a loud squeaking noise—is this necessary?

A.—No, it indicates a poor fit of parts that may easily be remedied.

953. Q.—Does this noise indicate a defect that will interfere with the operation of the valve?

A.—No, it is merely annoying.

954. Q.—How can the noise made by a feed valve be noted to advantage?

A.—It will indicate about the amount of air that is being supplied to the brake pipe, and show to a certain extent the amount of brake pipe leakage existing.

955. Q.—How indicated?

A.—By the percent. of time the feed valve is open supplying the leakage.

956. Q.—Can this noise be noted to good advantage at a time that undesired quick action develops on a train?

A.—Yes, an effort can be made to apply the brakes while the feed valve is in operation, which will sometimes prevent undesired quick action when it would otherwise occur.

957. Q.—What is prevented in this way?

A.—Brake pipe leakage is prevented from starting the brake application.

958. Q.—Can the brake on the engine and tender be applied with the automatic brake valve, if the brake valve double heading cock is closed?

A.—Yes, by placing the valve handle in emergency position.

959. Q.—How does compressed air enter the application cylinder of the distributing valve?

A.—Through the blow down timing or maintaining port.

960. Q.—What is this port intended for?

A.—To maintain a higher brake cylinder pressure for emergency stops.

961. Q.—What pressure is obtained in the application chamber during an emergency application?

A. Atmospheric.

962. Q.—Why atmospheric?

A.—Because the pressure chamber equalizes with the application cylinder leaving the application chamber cut off.

963. Q.—How much air pressure is developed in the application cylinder of the distributing valve during an emergency application?

A.—About 93 lbs. from a 110 lb. brake pipe pressure.

964. Q.—Due to what?

A.—The pressure chamber equalizing only with the application chamber.

965. Q.—Does it remain at 93 lbs?

A.—No, it is reduced to 75 lbs. by the safety valve and maintained at 75 by a proportion of the blow down timing or maintaining port to the port in the equalizing slide valve leading to the safety valve when in emergency position.

966. Q.—And when the valve handle is returned to lap position?

A.—The safety valve reduces the pressure to 68 lbs.

967. Q.—What pressure is in the application cylinder when the brake valve handle is placed in release position after an emergency application?

A.—To about 15 lbs.

968. Q.—What causes this drop?

A.—The connection of the application chamber and application cylinder.

969. Q.—Is this drop in application cylinder and brake cylinder pressure in any way undesirable?

A.—No, if rules are obeyed, the application cylinder pressure during release after emergency will be of very little consequence.

970. Q.—Sometimes it is noticed that the brake on the engine re-applies after a heavy brake pipe reduction, the engine brake having been released with the independent brake previous to placing the automatic valve in release position?

A.—This is caused by the over-reduction in brake pipe pressure.

971. Q.—How produced?

A.—The over-reduction has caused the equalizing portion of the distributing valve to assume emergency position, the pressure was retained in the application chamber while the application cylinder pressure was exhausted.

972 Q.—And when the equalizing valve moved to release position with the movement of the automatic brake valve handle?

A.—The application chamber pressure expanded into the application cylinder re-applying the engine and tender brakes.

973. Q.—What is a complaint of this action on the part of an engineer an indication of?

A.—That he is in the habit of making too heavy a brake pipe reduction during brake applications.

974. Q.—What re-applies the engine brake after it is released with the independent valve, the automatic valve handle remaining on lap position?

A.—Brake pipe leakage is the general cause.

(To be continued)

Car Brake Inspection.

(Continued from page 246, August, 1919)

871. Q.—Can a table be arranged to show the disadvantages of unequal brake piston travel?

A.—It is shown in the following which is the effect of a 10 lb. brake pipe reduction on various piston travels, and the resultant braking ratio developed when this is 60 percent based on a 50 lb. brake cylinder pressure.

Piston Travel.	Cylinder Pressure. Lbs.	Effective Breaking Ratio. Percent.	Comparison with 8 in. Travel. Percent Greater.
4″	52½	63	130
5″	41	49	78
6″	33	39½	44
7″	27½	33	20
8″	23	27½	..
			Percent Less Than 8 in.
9″	19	23	16½
10″	16	19	31
11″	13	15½	44
12″	11	13	53

872. Q.—From a 70 lb. brake pipe pressure, what will be the result if a full service brake application is made, that is if the reduction is continued until the point of equalization of auxiliary reservoir, brake pipe and brake cylinder is reached?

A.—

Piston Travel.	Equalization Pressure.	Brake pipe reduction necessary to produce equalization.
4″	59 lbs.	11 lbs.
5″	57 "	13 "
6″	55 "	15 "
7″	53½ "	16½ "
8″	51½ "	18½ "
9″	50 "	20 "
10″	49 "	21½ "
11″	47 "	23 "
12″	46 "	24 "

873. Q.—As an example, a car with 6 in. piston travel will require but 15 lbs. brake pipe reduction to produce equalization or all the braking force obtainable, what brake pipe reduction will be required to obtain 50 lbs. cylinder pressure from a 10 in. piston travel?

A.—But 49 lbs. cylinder pressure can be obtained and this will require 21½ lbs. brake pipe reduction.

874. Q.—What pressure would remain in the auxiliary reservoir of the car with the 6 in. piston travel?

A.—About 55 lbs.

875. Q.—In the reservoir of the car with 10 in. piston travel?

A.—But about 49 lbs.

876. Q.—At what time is it exceedingly important to have as near as possible a uniform auxiliary reservoir pressure?

A.—It is important at all times, but especially so when descending long heavy grades with loaded freight cars.

877. Q.—After a 10 lb. brake pipe reduction, which one of these brakes will start to release first?

A.—Both will start to release at the same time, if triple valves are in good condition and brakes are in the same part of the train.

878. Q.—Which one will have the brake cylinder pressure exhausted first?

A.—The one with the 6 in. travel.

879. Q.—Why?

A.—Because there will be less brake cylinder volume to escape through the triple valve exhaust port.

880. Q.—After a 20 lb. brake pipe reduction, and with a slow increase in brake pipe pressure as could be expected with a long freight train which brake would start to release first?

A.—The brake with the 10 in. travel.

881. Q.—Why?

A.—Because the auxiliary reservoir and brake cylinder pressure will have equalized on the 6 in. travel at somewhere near 53 or 55 lbs. while the auxiliary of the 10 in. travel will not have quite 50 lbs. pressure, and naturally the one with the 10 in. travel will start to release first.

882. Q.—Or in other words?

A.—The triple valve of the 10. in. brake piston travel will move to release position when the brake pipe pressure reaches about 50 lbs., and the 6 in. when the brake pipe pressure reaches about 55 lbs.

883. Q.—In what way does unequal piston travel cause rough handling of trains?

A.—It creates a great difference in draw bar pull between cars, through unequal retarding effect which results in surges and sometimes in break-in-two of trains during brake applications.

884. Q.—What is the proper proportion of the auxiliary reservoir volume to that of the brake cylinder, when the piston travel is correct?

A.—3¼ to 1, or the auxiliary volume should be 3½ times that of the brake cylinder but to provide for clearance volumes, leakage, and loss of pressure due to lowering of temperature through expansion of the compressed air, the reservoir volume is made approximately 3½ times that of the brake cylinder with proper piston travel.

885. Q.—How do these volume proportions actually work out?

A.—From 70 lbs. pressure in the auxiliary reservoir, a 50 lb. brake cylinder pressure results from a 20 lb. brake pipe reduction, or the brake pipe, auxiliary reservoir and brake cylinder should have equal pressures as a result of the 20 lb. brake pipe reduction.

886. Q.—Then multiplying the cylinder volume by 3½ gives?

A.—The volume necessary in the auxiliary reservoir.

887. Q.—Is the same principle followed out in passenger or car brake installation?

A.—Yes.

888. Q.—What changes from PM or High speed brake equipment are made when a car is equipped with the LN brake?

A.—The P triple valve is replaced with one of the L type, a supplementary reservoir is added, and the high speed reducing valve is removed.

889. Q.—What is the size of the supplementary reservoir?

A.—It contains 2½ times the volume of the auxiliary reservoir.

890. Q.—Is there any change made in the size of the auxiliary reservoir?

A.—No, it remains the standard size for the PM equipment.

891. Q.—What is the proper size of reservoirs to be used with the various brake cylinders?

A.—

Brake Cydinder	Auxiliary	Supplementary.	Capacity in cubic inches.
10 in.	12 x 27	16 x 33	5,724
12 "	12 x 33	16 x 48	8,577
14 "	14 x 33	20½ x 36	10,158
16 "	16 x 33	20½ x 48	14,003
18 "	16 x 42	22½ x 54	18,967

892. Q.—Sometimes the supplementary volume is divided into two units, or two smaller reservoirs are used instead of one large one, what sizes are then used?

A.—

Brake Cylinder.	Two reservoirs.	Capacity each.
10 in.	12 x 33	3,088
12 "	14 x 33	4,476
14 "	16 x 33	5,724
16 "	16 x 42	7,436
18 "	20½ x 36	10,158

893. Q.—Are the ordinary defects of the P and L triple valves the same?

A.—The causes for stuck brakes and undesired operation are about the same for both types of valves.

894. Q.—Must L valves be given the same attention as P with respect to packing ring leakage and friction?

A.—Yes, they must be given the same careful tests before being placed in service.

895. Q.—Is the L valve ever used to replace the P valves without using the LN brake equipment?

A.—Yes.

896. Q.—In this case the high speed reducing valve is sometimes left on the car?

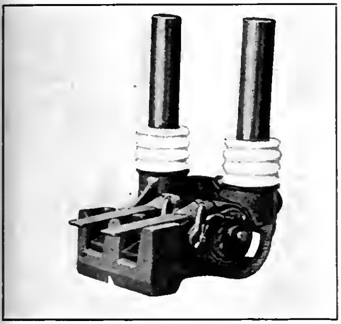
A.—When it is, the safety valve of the triple valve is generally removed and a plug inserted in the safety valve passage.

(To be continued)

Electrical Department

The Flashing of Electric Motors—The Cause, and Elimination of Such Failures

One of the common failures of railway motors is flashing. While the design of railway motors has advanced rapidly during the past few years and the troubles due to flashing has been practically eliminated by the introduction of interpoles, still flashing can and does occur due to some good reason other than design. There are many factors which may cause the flashing and these will be taken up one by one and an explanation given as to the reason for and the elimination of the cause.



RAILWAY MOTOR BRUSH HOLDER.

Flashing is commonly known as "bucking" and is primarily caused by poor commutation, which results in a sudden breakdown of the insulation over the face of the commutator from the brushholder to the motor frame or ground. There is a sudden rush of heavy current which should cause the circuit breaker to blow. Many times the breaker is slow in opening and the current or flash hangs on as an arc, badly burning the motor parts.

The results from flashing are varied. The motor may be so badly damaged that it is inoperative, and it will be necessary to take the whole motor apart and overhaul; the armature windings must be repaired, the commutator cleaned where it has been burned and blackened, the wiring put into good condition, generally by replacing by new wire, and the brushholders repaired or else replaced by new ones.

Again the flash may have cleared itself instantly and the motor is not so badly damaged but that it can stay in service until the terminal is reached. It is, however, necessary to give this motor a careful inspection for any damaged parts that need attention.

There are certain conditions that tend to produce flashing as follows: 1. *Design.* The older types of motors did not embody the interpole, so that these motors cannot stand sudden changes in current and voltage conditions as can the interpole motor, so that there is a greater tendency to flash. The design may be such that fundamentally the motor is not stable. We speak of a motor being stable, which can stand up under varying load and operating conditions without flashing. Some motors are sensitive to fluctuations. With constant load conditions the motor may be satisfactory. Railway operating conditions are far from being constant, so that a sensitive motor is not a desirable one.

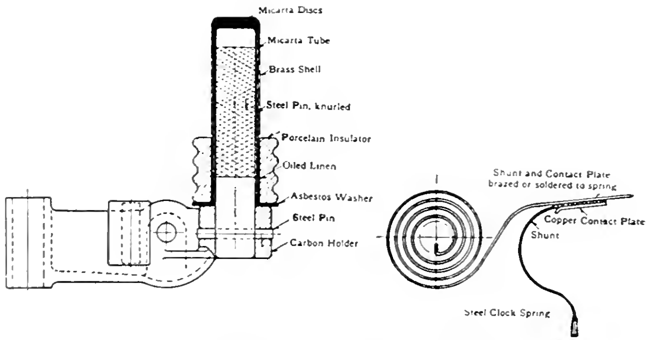
Another point under "Design" is high voltage between adjacent commutator bars. The voltage between bars is rather of an important point. The higher this voltage the more tendency to flash over, as with, say, a slight spitting of the higher voltage will jump and start the flash. This voltage between bars is governed by design and will depend on the number of bars between the brushholders, or on the total number of commutator bars. The total voltage is across the two adjacent brushholders, so that the voltage between bars is equal to the voltage divided by the number of bars between holders. As an example, if the motors were operating from a third rail at 600 volts and there were 450 bars between brushholders, then the voltage between bars would be 133 volts, whereas if there were 65 bars the voltage would be 9 volts between bars.

The design of the motor cannot be changed without practically rebuilding the motor, so that where considerable difficulty is encountered due to the flashing it is best to replace by a modern motor.

2. *Commutators.* The commutators should be tight and have a smooth, highly polished, clean face. They are made of a large number of copper segments insulated from each other by mica. The segments are held tight by V-rings. Flashing may be caused by high bars, low bars or loose bars. Due to the drying out of the insulation, etc., and on account of the centrifugal force due to rotation, a single bar may be thrown out slightly, and it becomes a high bar. It projects slightly above the surface, so that the brush is hit at every revolution, is bounced and causes flashing. In the same way a bar may work down below the surface. The bar may be loose, so that when checking for trouble a high bar will not be found, but will actually exist when the motor is running, due to the centrifugal force throwing the loose bar beyond the surface of the commutator. If loose bars are found, the commutator should be heated to soften up the mica V-rings, etc., and then the rings tightened down. All the high and low bars should be ground out if possible, if not the commutator should be turned in a lathe.

Other conditions may exist on the commutators which will cause flashing. There may be flat spots, poor undercutting of mica, sharp edges and corners on the commutator bars and dirty commutators. Flat spots generally begin at a high or low bar. A slight burning at the surface begins and spreads to several adjacent bars, so that there is a flat spot. These spots should be ground out at the time the commutators are trued.

It is general practice now to cut the mica between the segments, so that the top edge is below the copper surface. It is called "undercutting." If the undercutting is not properly done, mica flakes



DETAILS OF TYPICAL RAILWAY MOTOR BRUSH HOLDER.

will be left in the slots which must be removed. In fact it is practically impossible to saw out all of the mica, and it is important to clean out thoroughly all of the mica from the slots. The undercutting is accomplished by a small circular saw, about 0.005 inch thicker than the thickness of the mica, which revolves at approximately 2,000 r. p. m., and which is drawn towards the operator so that he may guide the cut. The cutting edge of the saw should revolve in a direction towards the operator while it is cutting the mica.

A small diameter saw must be used in order to cut the slot to the proper depth and at the same time not cut into the neck of the commutator. The mica should be cut to a depth of 3-64 inch. After undercutting, the sharp edges should be rounded off. The commutator face should be kept free from oil and dirt so that the brushes will always be in contact with the commutator.

3. *Brushholders.* The condition of the brushholders is very important. There may be lack of spring tension; the location or setting of the holders may be incorrect; the carbon box may be worn; or there may be too small clearances to ground. The carbon brushes are held against the commutator at a pressure depending on the setting of the spiral spring. A broken spring would remove the pressure and the carbon brush would not keep in touch with the commutator. The pressure might be weak causing flashing also. On the average the tension on the carbon brushes should be kept at approximately five to seven pounds per square inch and if the pressure is weak the tension can be increased by winding up the spiral spring. It is necessary to keep the mechanism oiled and free so that the pressure finger will not stick. The mechanism wears and must be replaced when badly worn.

The brushholders should be set approximately 3-16 inch from the face of the commutator and the sides should line up parallel with the commutator segments. If the bottom of the brushholder box is set too far away, the carbon brushes will project too far and will break.

Incorrect spacing of the brushholders will cause flashing. The distance from the center line of one box to the center line of the other box, on a four-pole machine, should be equal to one-fourth of the number of commutator bars, and ordinarily the carbon brush will be opposite the middle of the main poles.

If the box of the brushholder is worn wider than normal, it will allow the brush to swing off the neutral. When badly worn the brushholder should be replaced by a new one.

The clearances to ground, of the brushholders, is important. The brushholder must have sufficient creepage distance in itself so that the current will not creep over the surfaces to the point of support, which is the ground, and also must have insulation clearance which is the shortest distance from live parts to ground. The clearance should be approximately ¼ of an inch and, if any less, insulating arc shields should be used, located in the space between the live part and ground. The short distance is thus eliminated.

4. *Carbon brushes.* Poor commutation can sometimes be greatly improved by changing to a higher grade of carbon brush. It is difficult to select a grade of carbon brush for railway motors by a casual inspection. To secure the right brushes requires a thorough knowledge of the various grades. Carbon is a non-metallic element found in both crystalline (made of crystals) and amorphous (non-crystalline) forms. Natural graphite is carbon of the first mentioned formed and coke or lamp-black of the second form. By heating the amorphous or non-crystalline carbon, such as coke, in an electric furnace, artificial graphite can be obtained. There are four general classes of brushes (a) carbon brushes made of crushed coke held together by a binder; (b) graphitized brushes made of carbon and changed to graphite by heating in an electric furnace; (c) graphite brushes made of natural graphite and binder, and (d) metal graphite brushes made of natural graphite mixed with metal powder and held together by a binder. On the modern railway motors the best all around results will be obtained by the use of graphitized brushes. The next best results will be secured by using a carbon brush. Graphite brushes are for very special and limited uses and rarely used on railway motors, while metal graphite brushes are not used at all.

The carbons must be carefully inspected as they are a very important factor in satisfactory operation. Brush conditions may easily produce flashing. A carbon or carbons may be too long or too short. If the carbons are too long the resultant pressure of the brushholder tip on the carbon is not on the top of the carbon, and hence the pressure on the commutator is light. If too short, the carbon may reach a point where there will be no pressure due to the tip reaching bottom of the slot in the brushholder box. The carbons may be too loose in the box or too tight. In the first case they will vibrate and in the second case will bind so that the spring is not of sufficient strength to push the carbon against the commutator. Flashing can easily occur from broken brushes.

1. Design	Non interpole type, Stability, High voltage between commutator bars.
2. Commutators	High bars, Low bars, Loose bars, Flat spots, Undercutting of mica, Sharp edges, Dirty commutator.
3. Brushholders	Broken spring, Weak spring, Too far from commutator face, Incorrect spacing, Worn carbon box, Clearances to ground.
4. Carbons	Too long, Too short, Loose in box, Tight in box, Broken.
5. Windings	Loose brushholder connection, Defective wiring around frame, Wrong connection of leads to commutator. Short-circuited coil, Reversed coil.
6. Operation	Faulty control, Too rapid acceleration, Plugging, Sudden voltage changes or surges High speed.

SUMMARY OF CONDITIONS THAT TEND TO PRODUCE FLASHING OF RALIWAY MOTORS.

5. *Windings.* The cause of motor flashing may be traced to loose wire connections to the brushholders or to a broken or worn lead. The armature may be incorrectly connected, i.e., the armature leads do not connect to the proper commutator segments. The main field coils may be short-circuited resulting in a weak field; it may be reversed, i.e., put into the motor frame upside down.

6. *Operation.* Conditions can easily exist where flashing will occur, although the motor itself is in good condition. One of the first things to consider is the operation of the control apparatus. Does the control function incorrectly so that it allows sudden voltage changes at the motor terminals? The acceleration may be too rapid, which means heavy drafts of current. Sudden reversal of current through the motor called "plugging" will tend toward flashing. On nearly every system, in fact, all system electrical surges occur due to sudden variation of load conditions. These voltage surges may be from two to three times normal. Troubles may exist caused by breaks in the third rail. High speed, down grades especially where speed above the normal can easily be secured, will cause flashing.

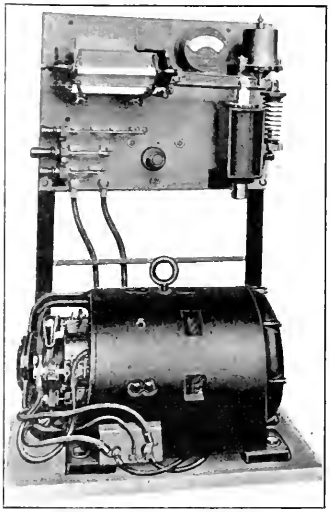
The following is a summary of the points which have been discussed above. If trouble is experienced a careful investigation should be made along these lines of suggestion so as to get at the real source of the trouble.

The accompanying table on the preceding page is a detailed and accurate summary of the conditions that generally tend to produce flashing of railway motors.

New Design of Welding Unit.

A new plastic-arc welding unit has just been brought out by the Wilson Welder & Metals Company, 2 Rector Street, New York. This set is composed of a dynamotor and current control panel. The generator is flat-compound wound, and maintains the normal voltage of 35 on either no load or full load. The control panel contains many new features. It has been designed to provide a constant-current controlling panel, small in size, of light weight, simple in operation and high in efficiency. The panel is of slate, 20 in by 27 in., and on it are mounted a small carbon pile, a compression spring and a solenoid, working in opposition to the spring. The solenoid is in series with the arc so that any variation in current will cause the solenoid to vary the pressure on the carbon pile, thereby keeping the current constant, at the value it is adjusted for.

This is the well-known principle of the Wilson control of constant heat in the weld. Practically any metal can be welded with this outfit, without preheating or annealing, which are so troublesome. Three switches on the panel provide an easy means of current adjustment, between 25 and 175 amperes. The arrangement of the welding circuit is such that 25 amperes always flows through the solenoid when the main switch is closed, whether the welding current is at the minimum of 25 amperes or the maximum of 175 amperes. The balance of the welding current is taken care of in by-pass resistances shunted around the solenoid.



NEW PLASTIC ARC ELECTRIC WELDING UNIT.

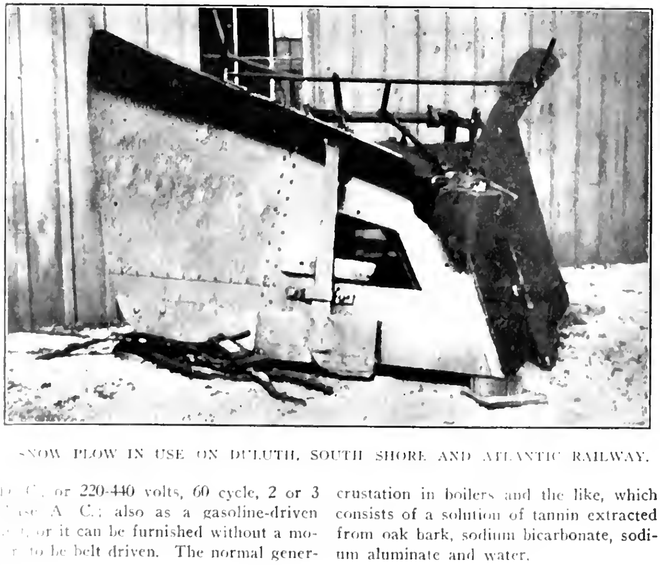
This outfit can be furnished as a dynamotor unit with standard motor characteristics as follows: 110 volts, 220 volts D. C., or 220-440 volts, 60 cycle, 2 or 3 phase A. C.; also as a gasoline-driven set, or it can be furnished without a motor to be belt driven. The normal generator speed is 1,800 R. P. M. The net weight of this new outfit in standard characteristics is 800 lbs. with D. C. motor, 807 lbs. with A. C. Motor, 1,200 lbs. with gasoline engine and 550 lbs. as a belted outfit without motor. These new dynamotor sets can be mounted on a truck for portability, if desired.

Pilot Snow Plow—Duluth, South Shore & Atlantic Ry.

The Duluth, South Shore & Atlantic Railway runs across the northern peninsula of Michigan, a land of pure water and deep snows. As a part of the snow-fighting equipment each locomotive is fitted with an unusually substantial pilot snow plow.

The face of the plow is made of heavy plates, curved at the top into a deflecting flare to throw the snow away from the track as it rises. At the bottom there is a track flanger at each side which can be raised and lowered by levers and connections located within the faces. These connections are built in as a part of the plow so that when it is attached to the pilot the whole is ready for immediate operation without the necessity of making any further attachments to the locomotive bumper.

The whole is substantially braced from the rear, and at the bottom lies close against the nosing of the pilot, so that the projection is not much beyond the point of the same. The coupling here is a notch cut in the front and is not interfered with in any way.



SNOW PLOW IN USE ON DULUTH, SOUTH SHORE AND ATLANTIC RAILWAY.

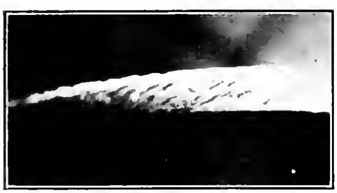
Incrustation in Boilers.

A French engineer has patented a composition for preventing and removing incrustation in boilers and the like, which consists of a solution of tannin extracted from oak bark, sodium bicarbonate, sodium aluminate and water.

Physical Tests of Chisel Steel

A number of years ago a representative of this paper chanced to express the desire to possess a good cold chisel to the superintendent of a large railway shop. He was told that a representative of Pompton steel was in the blacksmith shop demonstrating the value of that steel for chisel purposes and that he would probably be glad to make a chisel for him. This was done, and the pleasure of witnessing the artistic care with which this demonstrator manipulated his metal will never be forgotten. In his work he was more than particular about the working temperature, a clear cherry red, and the hammering, was a real anvil chorus. The delicate blows on the edges, the full face blows on the flats, and always, always this artist insisted, finish the chisel with work on the flat side, and leave it without a hammer mark visible on any surface. Then grind and afterwards heat to a bright cherry that is about 1450 deg. Fahr. and quench in water and draw to just the suggestion of a blue on the edge. That treatment gave the receiver a chisel that he cherished as the most valuable among his tools, and one that he regards as a nonpareil for years. And he boasted that after it had been finished he had seen the maker drive it through a ¾ in. bar of iron, and no injury done. And the steel from which this chisel was made? Merely a .88 carbon steel with a fracture like a piece of silk and whose sole worth was in the making, that is the care with which it had been made and treated.

But now it seems that this excellent steel is obsolete and quite out of date in comparison with one made by the same company (The Ludlum Steel Co.) for chisel purposes. It is known by the trade



EDGE OF CHISEL DRIVEN INTO STEEL CASTING, MAGNIFIED 7 TIMES.

name of Seminole. The peculiar and valuable properties of the metal are due to the percentage of alloys used and the method of adding them in the process of manufacture.

Those of our readers who were at the railroad convention at Atlantic City in June, will remember the demonstration of the steel made by the representative of the Ludlum Co. at that time and place. These demonstrations had been forestalled by the article on the steel published in our issue for May, and the excuse for presenting the matter again at this time is to emphasize the value of the material and

POINT OF SPIKE DRIVEN THROUGH STEEL CUBE, MAGNIFIED 7 TIMES.

present some additional features that were not mentioned at that time.

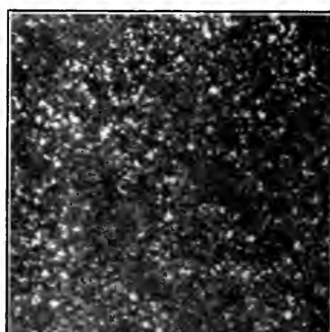
As stated in our previous article the steel is intended primarily for a chisel steel. And while it is almost foolproof, the fundamental rules for the making of a chisel must be followed in so far as the hammering is concerned. That is the blows on the edges should be light and the finishing blows should be on the flat sides. But beyond this the metal does not require any of the care usually applied in the manipulation of steel. In the first place the forging and tempering temperatures are much higher than would be permissible with ordinary carbon steel. It can be worked with impunity at an almost white heat, or 1900 deg. Fahr. a temperature at which the usual carbon steel would sputter and fly to pieces if it were struck. Then for tempering the quenching heat should be a bright red of about 1800 deg. Fahr. and the quenching should be done in oil which stands at about the temperature of the atmosphere. After hardening instead of drawing down to a faint blue on the cutting edges the metal is quenched as soon as there is the first faint indication of color. It is too light to be called a straw and the change from the bright surface, made by rubbing the surface with emery paper after hardening, is too insignificant to be noticed unless the eyes are following the effect of the heat. When this slight rise has been indicated the temper is drawn and the tool is cooled in water.

Here then is a hard tool, but the metal, in spite of its hardness, can be bent, as shown by the illustration. The chisel illustrated was straight and true when it had been finished and tempered. The only thing done to it to fit it for work was to grind it. And as indicative of the high temperature at which it had been quenched the corners at the edges showed every evidence of having been melted. After it had been ground it was first driven directly into a steel casting to the depth of ½ in. with the result on the cutting edge as shown by the enlarged photograph, where it is shown magnified seven times. Even this magnification indicates that the edge was left smooth and straight. The chisel was then laid across the anvil and bent out of line, a thing that it would have been impossible to accomplish with a tempered carbon steel and a most remarkable performance with a chisel as hard as this one was.

Another fact that attracted a good deal of attention at Atlantic City was the driving of a slender spike made from ⅜ in. cold Seminole steel through a cold steel cube of 25 carbon measuring 1⅛ in. on each edge. Such a spike after it had been driven through is shown in the accompanying engraving. The start of the driving is made with a small hand hammer weighing about 1½ lbs. After the spike had penetrated to a depth of from ⅜ in. to ½ in. it is driven the rest of the way by lusty blows with an 8 lb. sledge.

The reproduction of the point of the spike shows it magnified seven times from which it appears that it suffered no injury whatever from its rather strenuous journey through 1⅛ in. of steel.

These two demonstrations are practical duplications of those described in our May issue and are reproduced here merely because of the larger magnification of



MICROGRAPH OF STRUCTURE OF SEMINOLE STEEL MAGNIFIED 87 DIAMETERS.

the point and cutting edge that is here presented for the first time.

The microphotograph shows the grain of the metal multiplied to 87 diameters,

from which the homogeneity of the metal may be judged.

It will be seen from this micrograph that the texture of the metal is very uniform and appears on the surface at this magnification like a piece of comparatively low carbon steel that has been very carefully and skillfully heat-treated. A lower magnification of only 46 diameters brings out this structure more emphatically than the larger magnification.

We have become so accustomed to the remarkable performances of alloy steels in these later days where red hot tools peel off the chips by the hundreds of pounds to the hour that things of the sort are taken as a matter of course.

MICROGRAPH OF STRUCTURE OF SEMINOLE STEEL MAGNIFIED 46 DIAMETERS.

But when we consider the limitations of a few years ago, such performances as those described of the Seminole steel are, even in this day and generation, are certainly remarkable, and are worthy to be marked again as a notable achievement.

Creosoting Railroad Ties.

It is believed that less than half the ties used on American railroads are creosoted, notwithstanding the records of roads that have been using creosoted ties for years indicate that creosoting increases the life of a tie to an average of eighteen years. In other words, creosote more than doubles the life of the tie. It would appear from this, therefore, that creosoting generally would cut down the number of tie replacements from about 68,000,000 per year to about 30,000,000. The cost of a creosoted tie, including the labor of laying it, amounts to about $1.60 per tie. It is easy to see what an immense saving could be effected by using 30,000,000 ties yearly at a cost of $1.60 per tie as against 68,000,000 at a cost of $1.35 per tie, considered in connection with the fact that the $1.60 tie lasts eighteen years, as compared with a life of eight years for the $1.35 tie.

Colloidal Fuels and Their Relation to the Coal Crisis

We took the opportunity recently to publish the results of experiments with colloidal fuels, which has been the subject of considerable enquiry by our readers, with a general expression of a desire for further data as to the merits of powdered coal with oil fuel as an aid in the economical use of fuel in steam generation generally and in railroad practice particularly. This spirit of enquiry is not to be wondered at in view of the published statements of the National Coal Association that never before has there been such danger to the steam coal industry from fuel oil as threatens at present, with everything pointing to the probability that in the near future this competition will be even more dangerous to coal. This condition is due to a number of factors, of which the principal ones are:

Increased cost of coal production, due principally to the advance in labor, but also to price of mining equipment. Increased railroad freights from mines to consumers, and increased output from Mexican oil fields producing heavy oils, which can be sold for steam purposes at low prices.

The United States Geological Survey has also shown coal famine to be imminent. The shortage of bituminous coal alone is estimated at over three hundred thousand tons a day. The question naturally arises—wherein is the largest source of avoidable waste? How may conservation be greatest with the least effort—where can one gain the most good with the smallest departure from present customs and with the fewest changes in the mechanisms or designs of boilers, engines and furnaces? Two basic truths give answer. The most avoidable waste is in the burning of solid fuels. The most practicable conservation is in converting solid into liquid fuel. It is also, happily, as society and prices are constituted, a most profitable operation for producers and consumers.

The fact is, that on land and sea fuel liquid is superior to fuel solid, no matter how the latter be fed to the flame, whether hand fired, mechanically stoker-fired or pulverized, with its particles ridding and bathed in streams of air. Liquid fuels fed atomized into a furnace are from one and a quarter to one and three-quarters times as effective and as economical as the quantity necessary for producing the same number of BTU in any solid carbonaceous fuel. Many factors govern and decide this broad fact. One is that solid fuel cannot be so finely divided as can liquid for the rapid and complete oxidation, necessary to the phenomena which give rise to heat.

It takes by the accepted standard 33,479 British thermal units to yield a boiler horsepower hour. A boiler that would deliver a horsepower for that number of heat units would show 100 per cent efficiency. The goal has, however, never been and it never can be reached. It is a goal, nevertheless. The craving of invention is never satiated for it is never satisfied.

In the use of oil fuel in locomotive experience it may be stated briefly that as long ago as 1882 and 1885 in Russia on locomotives, service tests were made and were averaged over these years. The oil analysis gave per pound 18,600 BTU and the coal 14,000 BTU. One pound of oil proved equal to 1.78 pounds of coal. That is oil rated at 18,600 BTU did the work of coal rated at 24,920 BTU, or speaking in symbols of ratios of work, 1,000,000 BTU in oil equalled 1,340,000 BTU in coal. Oil burning has much improved in forty years, as better burners have been developed, therefore another recent report shows that the average weight of water evaporated per pound of oil on "10 wheel," Consolidated and Mallet locomotives is 14.38 pounds, while coal gives 7 pounds, a ratio in pounds of 1 to 2.054. Here again liquid analyzing 18,600 BTU does the work of coal containing 28,756, a ratio represented in 1,000,000 BTU for oil against 1,545,000 BTU for coal.

The advantages of oil burning generally admitted are: The release of engines and rolling stock required for carrying coal; the saving cost unloading and stacking coal and putting on tenders; locomotives cleaner and more comfortable for the staff and easier work for the firemen, also in special cases there is a saving of one fireman per engine; saving of fuel during periods locomotives are standing at stations or in yards; rapidity with which steam can be raised; larger blast pipes can be used to reduce back pressure in cylinders; less wastage of fuel in transit; absence of sparks and smoke when the admission of air, steam and fuel are properly regulated; no ashes to be removed from ashpans, or smoke-box or ashpits to be cleaned.

According to Kent in 1892 there were reported to the Engineers' Club of Philadelphia some comparative figures from tests undertaken to ascertain the relative value of coal, petroleum and gas. The following is the official data:

Lbs. Water from—	And at 212° F.
1 lb. anthracite coal evaporated..	9.70
1 lb. bituminous coal evaporated.	10.14
1 lb. fuel oil 30° gravity.........	16.48
1 cubic foot gas 20 C.P..........	1.28

Fluid-fuel possesses numerous other distinct and proven advantages which

must be appraised differently for diverse duties. These also may be reduced to ratios and when these increments are added to the above efficiency ratios of solid fuel there will result the definite guides to the physical and financial usefulness of fluid against solid fuels which is sought.

The losses by inferior regulation to meet changes in heat or steam demand are acknowledged by authorities to be greater with coal than with liquid fuel. Boilers are almost instantly responsive to atomized firing. Steam is raised more slowly and drops more slowly with coal. Every service and every power or heating plant has a different load curve. With coal in major power stations five to six per cent of the fuel goes to banking. In minor plants this figure is doubled. Given intelligent burner-valve regulation the increment of advantage to fluid fuel is certainly not less than 4 per cent.

Heretofore coal and oil have traveled side by side, enemies not friends. The ultimate future is unto Coal since Oil is relatively short-lived. A hundred years must find its story told. There will still be coal when there is no more oil—save as it be distilled from shale. In this time, however, of half a world calling for industrial resurrection, all the coal that can be mined and all the oil that may be won are needed. Each should support the other. To accomplish this support and union have come Colloidal Fuels. They are coal in liquid guise. They are composed of myriads of microscopic and ultramicroscopic coal particles habited in oil.

Up to over 40 per cent by weight of coal and 59 per cent oil, colloidal fuels are liquid. It is of these that recent extensive experiments have been made. The gels and pastes with higher coal percentages have also been experimented with. As the coal percentage is increased, the composite passes through denser stages from a thin mixture, into thicker, but nonsticky, mobile pastes, movable under well-directed pressure—pumpable and atomizable up to 65 per cent coal content.

Colloidal fuel has demonstrated the fact that it can save the coal pile and increase by from 25 to 75 per cent the thermal value of the tonnage. It does by fluidizing a solid. Every rain drop has its speck of cosmic or earth dust, ready to explode when highly heated.

For practical use, the "stability" of a liquid composite of oil and carbonaeous substances is relative. The word falls short of expressing the physical characteristics which suffice for the service wanted. Stability does not imply stagnation. In the liquid state, matter is ever restless. Up to the critical movement when Colloidal-like liquid-acting substances pass into gels, the fluid is full of small streaming currents, visible and invisible, of definite and indefinite direction, full of vibration waves, affected by inner plastic friction, surface and internal stresses, the operating pull of gravity, the quiver of the container. The gel is the sleep of a colloid. The gels of some Colloidal fuels are so delicate that sharp pencil tap upon a test tube will shock them back to liquids again. Certain substances and treatments will promote stability and accelerate the gel condition. After a long state of complete rest a brief stirring or setting up of circulation will make the liquid homogeneous again, to begin a new cycle of very gradual densification from the bottom up. What is needed is adequate stability for pumpability and atomizing when wanted, and this is what Colloidal fuels have.

On a fire tube boiler rated at 403 B.H.P. and developing 464 and 504 B.H.P. there was consumed each second .3 and .3571 pounds of Colloidal grades 14 and 13. This corresponds to 4.08 oz. and 5.71 oz. respectively. The initial velocity of the "atomized" spray at the burner is yet unmeasured but is in excess of 650 feet per second. The word "atomized" is not chemically correct. The tiny particles of the black fog which combine fiercely with the instreaming oxygen are doubtless in diameter from $\frac{634}{100,000}$ centimeter down to $\frac{1}{10,000,000}$ centimeter, or the least size that will reflect light in the intense beam of the ultra-microscope and many liquid droplets or molecular groups are still smaller, but above atomic dimensions.

When the relatively cool, small specks are "atomized" and flung, a vapored mist, instantly into a white hot furnace the oil that is in these seams and cavities flashes into gas, rending the molecular groups apart where the alert oxygen of the rushing draft can instantly combine with still smaller fragments of particles of naked incandescent carbon. It is in these phenomena that we find warrant for the record that Colloidal fuel has in it the making of a something which is richer in heat efficiency even than straight oil.

The properties of Colloidal fuels may be summarized as being liquid and handle and atomize for combustion like fuel oil. They contain more heat units than fuel oils. They contain very little moisture, are low in percentage of ash and sulphur. They are vaporless, and thus create no explosive mixture with air. Their flash point is about 200 F. They are immune to spontaneous combustion. They will weigh from $8\frac{3}{4}$ to $11\frac{1}{2}$ lbs. per gallon, according to the kind and percentage of coal pitch or coke employed. In exact comparison with the best anthracite coal, the weight of which in lump form is 28.8 lbs. per cubic foot, the weight of Colloidal fuel is 29.7 per cubic foot. The anthracite coal heating capacity ranges from 800,000 to 900,000 British thermal units per cubic foot, while Colloidal fuel contains 1,196,-800 units per cubic foot.

In regard to the financial aspects of Colloidal fuel, it may be briefly stated that in a locality where the cost of manufacture of a ton of Colloidal fuel is $1.50, and the coal stock on hand is worth $7.50 per ton and a ratio of liquid fuel 1 to solid fuel 1 1/3 is taken—the gain by fluidizing is $2.50 per ton. This is enough to pay for the colloidalizing process and provide a margin of a dollar a ton of coal besides. These dollars snatched from the burning may be devoted to bettering the boiler plant, to installing the colloidalizing machinery or to other purposes.

In conclusion there is, as far as we are able to judge, such superior merit in Colloidal fuel that there cannot be too much of it when rightly distributed. The quantity of liquid fuel available may be doubled at the present rate of production. It can be all absorbed because America is not the only country that will be benefited, but all nations will share in the relief and at real money profit.

International Master Blacksmiths Association.

The twenty-fifth convention of the above association was held at the Hotel Sherman, Chicago, Ill., on August 19-21, 1919, President W. C. Scofield, presiding. The report of the secretary treasurer showed a membership of 375, and a cash balance of $741. A special committee was appointed to communicate with the officers of the American Railroad Administration with a view to becoming amalgamated with Section III, Mechanical.

The reports on special subjects included "Cost Accounting in Blacksmith Shops," by G. F. Hinkins, Westinghouse Air Brake Company; "Drop Forging," by J. D. Boyle; "The Heat Treatment of Iron and Steel," by George Hutton, New York Central; "An Up-to-Date Railroad Blacksmith Shop," by George Fraser, Atchison, Topeka & Santa Fe; "Reclaiming Scrap in the Railroad Shop," by Walter Constance, St. Louis-San Francisco, and "Powdered Coal for Furnace Heating in Smith Shop," by W. E. Gamble.

The following were elected officers: President, J. Carruthers, Duluth, Missabe & Northern; first vice president, W. J. Mayer, Michigan Central; second vice president, Joseph Grine, New York Central; secretary treasurer, A. L. Woodworth, Baltimore & Ohio. Birmingham, Ala., was selected as the meeting place of the next convention.

The convention was largely attended, and the discussions on the various subjects presented in the special reports brought out many interesting details of improved means and methods that have come into use since the last convention held in 1916.

Items of Personal Interest

T. R. Hannah, chief fuel inspector of the Grand Trunk, with headquarters at Montreal, Que., has retired after forty years of continuous service with the company.

H. P. McQuilken, assistant storekeeper of the Baltimore & Ohio, Eastern Lines, has been appointed general storekeeper of the Baltimore & Ohio, the Cumberland Valley, the Western Maryland and the Cumberland & Pennsylvania, with headquarters at Baltimore, Md.

P. H. Shay has been appointed storekeeper of the Lehigh Valley, with office at Caxton, Pa.; Gordon Thomas, to a similar position at Hazleton, Pa., and R. E. Walker, at Auburn, N. Y.

H. A. Wolcott has been appointed district manager of the Ohio Locomotive Crane Company, Bucyrus, Ohio, for the Chicago territory, with office in the Lyden building, Chicago.

Lieut.-Col. Elmer K. Hiles, Engineers, who went overseas as Captain in the Fifteenth Engineers, has returned from military service in France and has accepted a position as manager of the Pittsburgh Testing Laboratory, with headquarters at Pittsburgh, Pa.

Elliot Reid, assistant to the general manager of the Westinghouse Lamp Company, 165 Broadway, N. Y., has been appointed sales manager, and will have charge of the Commercial activities of the company in all classes of lamps in domestic territory.

L. E. Fletcher, master mechanic of the Atchison, Topeka & Santa Fe, at Raton, N. M., has been transferred to the Arkansas River and Colorado divisions, with headquarters at La Junta, Colo., succeeding H. Drake, assigned to other duties.

Frank Lamond has been appointed road foreman of engines of the Los Angeles division of the Southern Pacific lines south of Ashland, with headquarters at Los Angeles, Cal., succeeding R. N. Richardson, assigned to other duties.

F. T Ryan, general foreman of the Atchison, Topeka & Santa Fe at Las Vegas, N. M., has been appointed master mechanic of the New Mexico division, with headquarters at Raton, N. M., succeeding L. E. Fletcher.

J. Skelton has been appointed day roundhouse foreman of the Denison (Texas) locomotive shops of the Missouri, Kansas & Texas, succeeding J. T Smith, appointed night foreman.

R. R. Jackson has been appointed division storekeeper of the Pittsburgh division of the Baltimore & Ohio, Eastern Lines, with headquarters at Glenwood, Pa., succeeding T. C. Hopkins, assigned to other duties.

G. E. Scott, general manager of the Red Cross at Washington, D. C., having been honorably discharged, has resumed his duties as first vice-president of the American Steel Foundries, Chicago, Ill.

Albert Brunt, engineer in charge of the direct-current machine design section of the industrial engineering department of the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., has resigned to return to Holland.

J. H. Redhead has been appointed assistant to the vice-president in charge of the miscellaneous sales of the National Malleable Castings Company, Cleveland, Ohio, and C. C. Gibbs has been appointed sales agent of the Cleveland plant, succeeding Mr. Redhead.

COL. FREDERICK MEARS.

Col. Frederick Mears has been appointed by President Wilson as chairman and chief engineer of the Alaskan Engineering Commission, in charge of the construction of the government railroad in Alaska Col. Mears was one of the original members of the commission, but was called into active service during the war and was connected with the management of the railroads in France. William C. Edes, formerly chairman of the commission, has been appointed consulting engineer to the commission.

A. V. Hooks, formerly assistant engineer of the Southern Railroad, with headquarters at Charlotte, N. C., having been discharged from military service, has been appointed resident engineer of the Eastern district of the Southern, with headquarters at Charlotte.

T. S. Edgell, traveling storekeeper of the Mobile & Ohio, with headquarters at Murphysboro, Ill., has been appointed division storekeeper at the same headquarters, succeeding E. H. Landers, resigned.

Vester J. Thompson, having returned after three years' military service abroad, has been appointed supervisor of safety on the Mobile & Ohio, and the Southern, in Mississippi, succeeding H. L. Wright, promoted.

F. B. Hartman has been appointed representative of the Hunt-Spiller Manufacturing Corporation, with headquarters at Boston, Mass.

Bertram Smith, assistant general sales manager of the Edison Storage Battery Company, Orange, N. J., has resigned to become president and general manager of the Automatic Electrical Devices Company, Cincinnati, Ohio.

J. D. East has been appointed division storekeeper on the Baltimore & Ohio, Eastern Lines, with headquarters at Keyser, W. Va., succeeding C. S. Filler, resigned.

R. A. Sewell has been appointed superintendent of car service on the Canadian Pacific, with headquarters at Montreal, Que., succeeding O. M. Lavoie, promoted.

G. S. Lytle, car service agent of the Manitoba district of the Canadian Pacific, with headquarters at Winnipeg, Man., has been transferred to the Saskatchewan district, with headquarters at Moose Jaw, Sask., succeeding J. A. Perry.

K. R. Hare has been appointed district manager of the Transportation Engineering Corporation, New York, with headquarters at Chicago, in charge of the territory in the middle west.

J. R. Smith, chief electrician of the Minneapolis, St. Paul & Sault Ste. Marie, with headquarters at St. Paul, Minn., has been appointed signal supervisor, with headquarters at Minneapolis, Minn., succeeding E. B. Dodd, assigned to other duties, and S. D. Dimond succeeds Mr. Smith as chief electrician.

E. T. Sawyer has been appointed a representative of the railway sales department of the United States Light & Heat Corporation, Niagara Falls, N. Y. Mr. Sawyer will specialize in car-lighting equipment and electric car welders, with headquarters in New York.

Hon. Frank Carvell, who has resigned as Minister of Public Works in the Canadian government, has been appointed chairman of the Board of Railway Commissioners for Canada, succeeding Sir Henry L. Drayton.

Henry Bartlett, who has been prominently active as a member of the Committee on Mechanical Standards, under the jurisdiction of the United States Railroad Administration, has resigned from the committee and entered the service of the Baldwin Locomotive Works, and has already departed for England, where he will represent the company's interests, particularly in Great Britain, and the British colonies generally.

E. C. Pierce has been appointed manager of the new branch office of the Baldwin Locomotive Works and the Standard Steel Works Company, Philadelphia, in the Union Arcade, Pittsburgh, Pa., and Charles E. Hale has been appointed assistant to Mr. Pierce.

J. M. Davis, formerly operating vice-president of the Baltimore & Ohio, and manager of the New York properties ot the same road, including the Staten Island lines, has resigned to become president of the Rock Hill Iron and Coal Company, with offices at No. 1 Broadway, New York. Mr. Davis has held official positions on a number of the leading railroads, both east and west, and is one of the most thoroughly trained railroad officials in the United States, and also one of the most popular.

L. Amperan has been appointed superintendent of motive power of the National railways of Mexico, including the Southeastern lines, now called the Ferrocariles Nationales de Mexico y Anexos, and Sixto Martinez has been appointed assistant superintendent, with offices at San Luis Potosi, Mexico.

The Centenary of James Watt. 1736-1819.

Notable celebrations in memory of James Watt, the inventor of the steam engine, were held last month by the members of various engineering and other societies, particularly in Great Britain. At the Masonic Temple in Brooklyn, N. Y., members of the Scottish-American societies, among whom are many engineers, held special memorial exercises. Dr. Peter Scott presided, and James Kennedy, managing editor of Railway and Locomotive Engineering, was the principal speaker. In the course of his remarks Mr. Kennedy said that James Watt was gifted with the mechanical faculty in an amazing degree. He learned in two years all that was to be learned in instrument making in London and returned to Glasgow and opened a shop in 1756. The labor unions of his day compelled him to close. He had not served a regular apprenticeship. The professors of the University of Glasgow, to their everlasting renown, came to his rescue. They found room for Watt in the university, beyond the reach of trades guilds. Here he experimented with steam, and in 1759 invented a steam carriage, but the slim boiler could not furnish sufficient pressure, and the carriage could hardly haul itself.

In 1764 he improved Newcommen's atmospheric pump by inventing a separate condenser. In 1765 he created the steam engine as we have it today. Financial disaster to the Carron Iron Works placed it in quiescence for ten years. Meanwhile Watt was not idle. He designed the Caledonian Canal and the Forth and Clyde Canal. He engineered the deepening of the river Clyde, changing Glasgow from an inland town to a seaport city. In the fulness of time Matthew Boulton, a Birmingham manufacturer, heard of Watt and his engine. A partnership was formed, a union of English enterprise and Scottish cunning that was destined to draw the ends of the earth together, and, in a measure, annihilate time and space. Emperors, kings, statesmen and ambassadors flocked to gaze on the mechanical marvel of the ages. Watt went on with his work calm and unspoiled. The slide valve, the governor, the pressure gauge, the indicator, the water gauge, the turbine, the four-bladed screw propeller, the steamboat and the steam hammer are all of Watt's creation.

JAMES WATT.

We look in vain for anything at all comparable to his life work. Out of the grosser elements of the earth he had created an engine that accomplished the hardest part of the world's work. The utility and importance of his work is daily more felt. It is the crowning result that places civilized above savage men, securing the supremacy of intellect.

It is a joy to contemplate the fact that James Watt lived to a serene old age in close communion with nature in her beauty and solitude. He was the close companion of the brightest and best minds of his time. He was universally recognized in his lifetime as the foremost inventor of all the ages, and so, laurel crowned, he passed to an evergreen, jubilant immortality that cannot fade away.

Bulletins, Catalogues, Etc.

Electric Arc Welding.

The Westinghouse Company has just recently issued quite an elaborate publication covering the process of Electric Arc welding and the necessary apparatus required for this process. This publication compares the different processes of welding, such as Autogenous welding, Forge welding, Oxy-Acetylene welding, Thermit welding, and shows the advantages of Electric Arc Welding over these.

Some of the advantages of Electric Arc Welding shown are:

Economy, ease and convenience of application, speed of operation, reliability of results, reclaiming defective material, safety, conservation of material, less skilled labor required.

The field for Electric Arc Welding is unlimited and the process has made enormous strides during the last few years until now it is widely used throughout those branches of the metal industry in which work is done on iron or steel in rolled, cast or fabricated forms. New fields for its successful application are being discovered every day.

Electrical Precipitation.

Circular No. 7,375 issued by the Westinghouse department of publicity, East Pittsburgh, Pa., is of particular interest as recording a notable achievement in the field of electrical precipitation. The process applies to metal, acid and cement plants for the recovery of valuable material otherwise wasted. Water can be precipitated from oil, and dust removed from ventilating systems, and smoke or fumes removed from roundhouses. The apparatus are shown installed and described in the circular. As is well known, there are already several mechanical and chemical methods for collecting and suppressing dust in furnaces and kiln operation. They are, generally speaking, limited in application by conditions of temperature, acid, and similar qualities of the product to be handled. Electrical precipitation, on the other hand, has been found to have few limitations of this sort, and is universally applicable for collecting suspended solid and liquid particles of every variety or kind, whether acid, alkaline, or from gases of widely varying temperature. It is, indeed, another important advance in the scientific application of electricity in industrial operations.

Stoker Fired Locomotives.

The Locomotive Stoker Company, Pittsburgh, Pa., has published an elegantly illustrated booklet of 96 pages, showing the principal types of locomotives equipped with mechanical stokers furnished by the Locomotive Stoker Company, including the largest and most powerful locomotives, as well as the standard locomotives of the United States Railroad Administration. The various types of locomotives considered to be in the stoker class are grouped in sections, each page containing an illustration of a representative locomotive of different railroads, with a table of the principal dimensions. After each section is a tabulation which permits of a direct comparison of the like dimensions of all locomotives of that class. These tables should be of special interest to mechanical engineers designing new locomotives, as well as to those contemplating installing stokers on old locomotives.

Falls Hollow Staybolt Iron.

The Falls Hollow Staybolt Company, Cuyahoga Falls, Ohio, has issued an interesting circular describing the method of construction of the hollow bolt. It is enough to state that it is the only bolt made of bars to which roll action is applied to both the inner and outer surfaces, squeezing the intervening wall to a fine degree of elastic density, thereby greatly increasing the torsional strength required to resist the lateral stresses to which staybolts are subjected. The weakening effect of drilling a hole on the bar or bolt has been demonstrated beyond controversy. It detracts from the life of the bolt. The rolled hole adds to its durability. Hence the popularity of the Falls Hollow Staybolt. It is the boilermakers' best friend.

Isle of Wight Locomotives.

P. C. Walker, 11 Candler street, Stamford Hill, London, England, has compiled and published a curiosity in railway engineering literature in pamphlet form, setting forth complete data in regard to the locomotive in service on the Isle of Wight. It appears that there are three separate railways on the island—the Isle of Wight Central Railway, with six types of tank locomotives having a tractive effort of about 10,000 lbs. The Isle of Wight Railway, with four types of locomotives, with a little over 7,000 lbs. tractive effort, and the Freshwater Yarmouth and Newport Railway, another type of tank locomotive, with about 10,000 lbs. of tractive force. The varieties run from 2-4-0 type to 0-6-0, with a few of the 4-4-0 type. One curiosity named the "Terrier" took part in the speed trials on the Ouest railway of France, 41 years ago, and gained a gold medal at the Paris Exhibition in that year, and is still in service. The most of them seem to have been in service over a quarter of a century. Apparently their yoke is easy and their burden is light. The pamphlet is sold at one shilling, or 24 cents, per copy.

American Association of Engineers.

The young engineers, notably those recently returned from army and navy service, seem to be putting their surplus energy into the upbuilding of the local clubs and chapters of the association. They are not content with the narrow wisdom of their older associates. They want to join in state and nation-wide activities as well as in those of their own districts. In general, there is a good demand for engineers. From a special bulletin just issued, it appears that the development of railroad sections of the association forms one of the most interesting phases of the growth of this organization. It has been only four months since the board of directors authorized their formation, and in that time there have been organized 35 railroad sections, ranging in size from 20 members to 250 members on the Pennsylvania Railroad Section. The Southern Railway Section ranks next in size, with about 200 members. That the rapid development of these sub-organizations is not due entirely to the interest shown by younger engineers is indicated by an inspection of the roster of officers. The president of the Chicago and Western Indiana Section is F. E. Morrow, chief engineer of that railroad; the president of the Chicago and North Western Section is F. C. Huffman, principal assistant engineer; that of the Boston and Maine Section is F. C. Shepherd, principal assistant engineer; and that of the Pennsylvania Railroad Section is F. M. Sawyer, who is in charge of all construction on the Pennsylvania Railroad in the district comprising Pittsburgh and surrounding territory. In addition to a direct participation in the activities of A. A. E., these sections are bringing into close contact the engineers of each system. This is having a wholesome effect, especially on the larger systems. A significant feature of this development was the adoption of a resolution by the Pennsylvania Railroad System at its first annual convention, declaring against the use of union tactics in solving the problems of engineers and affirming the loyalty of Pennsylvania engineers to the management. At this convention A. M. Schoyer advocates co-operation as the one means of solving the problem.

Bridge and Building Association.

Merle J. Trees, 37 West Van Buren street, Chicago, secretary of the above association, announces that the twenty-ninth annual convention of the association will be held at the Hotel Stattler, Cleveland, Ohio, on October 21, 22 and 23, 1919. The Bridge and Building Supply Men's Association will hold their annual exhibition coincidentally with the convention. The membership in this association is open to all who are engaged in the manufacture of railroad material. Particulars in regard to membership, exhibit space, and other details may be had on application to the secretary. An unusually large attendance is expected this year.

Malleable Castings.

The Malleable Castings Association, aside from its various laboratories, has developed a highly-equipped research department at Albany, N. Y., for investigation and experiment for testing and analyzing the daily output of each member of the association. The result is that all its workers are brought to a high average quality in their products known as "Malleable Castings." After three months of approved analysis, a certificate of quality is granted so that each member may designate his output as "Certified Malleable Castings." A booklet on malleable iron containing much valuable information may be obtained without charge by applying to the American Malleable Castings Association, 1900 Euclid Building, Cleveland, Ohio.

Railway and Locomotive Engineering

A Practical Journal of Motive Power, Rolling Stock and Appliances

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New Santa Fe Type Locomotive for the Alabama & Vicksburg Railroad

Interesting Details of Comparisons Between the Santa Fe and Mikado Type Locomotives

Three Santa Fe type locomotives have recently been completed for the Alabama & Vicksburg Railroad by The Baldwin Locomotive Works. These locomotives are to be used for heavy freight service and are designed to operate on rails weighing seventy-five pounds per yard and over. They are of special interest as they illustrate the suitability of the Santa Fe type for heavy freight service on lines where track conditions prohibit the use of high wheel loads.

As far as practicable, the detail parts of the Santa Fe type locomotives interchange with those of Pacific and Mikado type locomotives previously built for the same road, and which have done excellent service in the severe track conditions incidental to the undulating nature of the country, not to speak of the mountainous ridges through which much of the railroad passes.

The boiler is a straight top design containing a fire-tube superheater. A Gaines Combustion Chamber is applied in connection with a Security Fire Brick Arch which is supported on four three-inch tubes. The front end of the firebox crown is suspended on three rows of Baldwin expansion stays which have been found admirably adapted to the stresses incidental to the variations in temperature in that part of the extended fire-box and its surroundings.

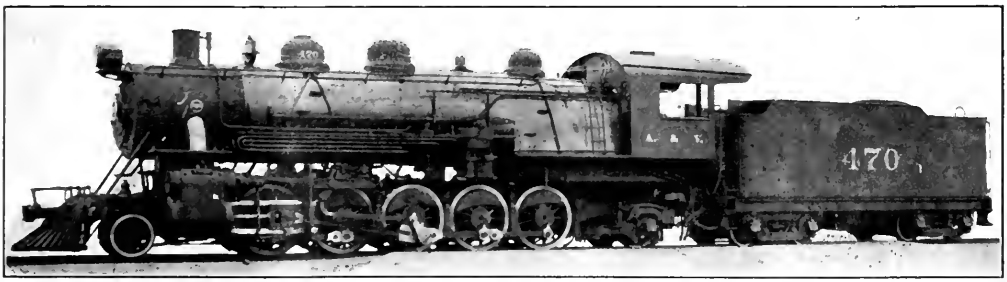
The main frames are of vanadium cast steel annealed. The bolster of the front truck is suspended on heart shaped links. The rear truck is of the Delta type, and is used in combination with the Commonwealth rear framed cradle.

Walschaerts valve motion is applied and is controlled by a Type B Ragonnet power reverse. The piston heads are of steel, and the packing rings are made of gun iron. The latter material is also used for the steam chest bushings and valve packing rings.

The main driving axles and rear truck axle are of chrome vanadium steel quenched and tempered in accordance with A. S. T. M. specifications. All wearing brasses including crosshead gibs and driving wheel hub liners, are of phosphor bronze. The pedestal wedges and gibs are of brass.

A power operated fire-door is applied.

The following table of dimensions will show the comparison between the Santa Fe and Mikado type locomotives built for the Alabama & Vicksburg Railroad by The Baldwin Locomotive Works:



SANTA FE [illegible] TYPE LOCOMOTIVE FOR THE ALABAMA & VICKSBURG RAILROAD.
Baldwin Locomotive Works, Builders.

	Santa Fe type	Mikado type
Cylinder dimensions	26 ins. x 28 ins.	22 ins. x 28 ins.
Drivers, diameter	57 ins.	57 ins.
Steam pressure	185 lbs.	200 lbs.
Grate area	58.7 sq. ft.	46 sq. ft.
Water heating surface....................	3,278 " "	2,573 sq. ft.
Superheating	754 " "	561 " "
Weight on drivers.......................	218,390 lbs.	168,400 lbs.
Weight total engine......................	274,715 "	217,500 "
Tractive force	52,300 "	40,400 "

The Narrow Gauge Railroads of the United States

The narrow-gauge mania in the United States was born of the bargain-hunting desire to get something far below its real value. It was at the time (in the early seventies) very difficult, if not impossible, to raise money for the construction of new railroads of the standard gauge. It was just after the Civil War and hard times were upon the country. Yet, in spite of this fact, the people over the whole land were clamoring for a more rapid development of the resources than was taking place, and this clamor was especially loud in its demand for an increase of railroad construction. But capital could not be obtained.

It then occurred to those that were most vitally interested in these constructions that if cheaper roads were to be built the money for their construction could be obtained. They immediately, therefore, jumped to the conclusion that because a gauge of 36 in. is but about three-fifths of one of 56 in. a road of that gauge could be built for a correspondingly lower price. And straightway positive statements were made to that effect, and they were honestly accepted by a large number of men. It was assumed that because the gauge was to be narrowed all costs could be cut down in a corresponding degree. It was argued that because of the narrow gauge the cars could be made lighter than those which it had been found advisable to use on the broad gauge, forgetful of the fact that equipment of the same or even lesser weight could and had been built and used on the standard gauge lines, and had been found to be unsatisfactory.

The articles sent herewith will give a clear idea of the arguments *pro* and *con* in the matter. The whole case rested, apparently, so far as the United States was concerned, on the inability to raise money for ordinary railroad construction, and the narrow gauge seemed to promise greater dividends on a given investment.

It was a characteristic of the whole discussion that the advocates of the narrow gauge insisted, throughout, that their construction was the cheaper, and could not or would not see their opponents' side of the case which was that the narrow gauge could not be built materially if any cheaper if the same facilities and capacity for the transportation of freight and passengers were to be afforded. They failed to see or acknowledge that a light locomotive and car could be built for a broad gauge line.

The physical disadvantages of the narrow gauge, such as cramped storage and seating capacity, the greater instability of the rolling stock, the decreased possible speed, the lesser tonnage capacity, and above all the chief drawback of all, the impossibility of interchanging cars with the standard lines, with the consequent extra cost and delays in transportation were repeated again and again.

But in spite of all this the narrow gauge construction went on for several years, and until the money market eased, made a great headway.

Meanwhile the disadvantages of different gauges were making themselves manifest, and it was being realized with great rapidity that heavy loads meant lesser costs than when light ones were hauled, so that between 1873 and 1885 there was a very rapid increase in the carrying capacity of the standard gauge cars, rising as it did from 10 to 30 tons. With this rise the dead weight of freight cars dropped from a ratio of 1 lb. of dead weight to 1 lb. of paying load to ½ lb. of dead weight to 1 lb. paying load.

Then the necessity of car interchange drove the broad gauge (5 ft. and 6 ft.) lines to narrow to the standard gauge, leaving the narrow gauge lines in a state of greater isolation than they had been at the outset of the movement.

Finally the recuperation after the panic of the seventies made money more easily procurable for railroad construction, and the narrow gauge roads that had been built and equipped in the lightest and cheapest possible manner found themselves doubly handicapped by their lack of facilities to do business and by their isolation.

Then came the reaction and the movement to change them to the standard gauge.

This change of gauge was usually a matter of years. It was found that to change a narrow gauge locomotive to the standard gauge did not give satisfactory results. The firebox of the small locomotive could not compete in the economy or consumption of fuel with the larger locomotives, and after a few trials of this sort the work was abandoned. The actual change of gauge was accomplished gradually. A third rail was laid to standard gauge, all new rolling stock bought was of that gauge, and the small locomotives were worn out, or, when the greater portion of the rolling stock had become of standard gauge they were sold to contractors or scrapped. The time required for this transition depended upon the size of the road and the traffic. In the case of some of the smaller roads the time was very short. For larger roads it was longer. For example, the first third rail on the Denver & Rio Grande was laid in 1881, and there is still a considerable mileage of the 3 ft. gauge.

In like manner the narrowing of the broad gauge to the standard took time. Where the change was made from a 5 ft. to the 4 ft. 8½ gauge the work was simple, as the difference was but 3½ in., and locomotives could be changed by merely slipping their tires on the centers, and the change was frequently made in a single day. But where the change was made from a 6 ft. gauge a third rail was laid, and there was a long period of transition during which trains of both gauges and composite trains made up of cars of both gauges were run. In the case of the Erie this transition period lasted for about twelve years. In this the locomotives had to be converted and that at a cost of about $3,500 each.

It is because of this gradual change of gauge that it is impossible to give any data regarding the cost. A third rail was laid, longer ties were substituted as the old short ones wore out or decayed, cuts and fills were widened a little at a time, extra ballast was put under the ties, broad gauge rolling stock was bought and used; the narrow gauge cars and locomotives were worn out, scrapped or sold, and the whole change is so interwoven in the regular maintenance and operating expenses of the road that it is quite out of the question to separate and differentiate them.

The result of it all is that, the furor past, the money market relieved, the narrow gauge mania died a natural death, if a death from lack of sustenance can be called natural.

The experience of the United States has found an echo in India where the narrow gauge lines are quite discredited, and are, apparently, only continued because of the inertia of the government that controls and operates them.

The result, then, of the forty years of practical experience that has elapsed since the battle of the gauges was precipitated in the early seventies has been to quite discredit the system. It has been proven beyond all peradventure that the narrow gauge railway cannot be operated so as to keep its ton-mile costs down to the figures obtained on the standard gauge roads, and this has been the cause of its demise. Cars and locomotives of present capacities are impossible on a 3 ft. gauge and time has shown that the contentions of the early opponents of the system were correct, and that the narrow gauge railroad cannot compete with the broad gauge in capacity, facilities offered, or in cost of operation, when this cost is put upon the ton-mile basis.

And, now, some are wondering whether the accidental 4 ft. 8½ in. gauge is the

best that could have been adopted. It is unsafe to conjecture, to say nothing of predicting as to whether we have reached the limits of dimensions and capacity of rolling stock for the standard gauge. Some thought that had been done thirty or forty years ago, and the discussions in the Master Mechanics' Association were in harmony with that idea.

Of course from our own present standpoint there is little probability of a widening of our present gauge, because of the tremendous expense involved, but the question still remains as to whether the adoption of a casual wagon gauge for the railroad of the world was not a mistake when viewed from the standpoint of present and future conditions.

The Counterbalancing of Locomotive Driving Wheels on the Chicago & Northwestern Railway.

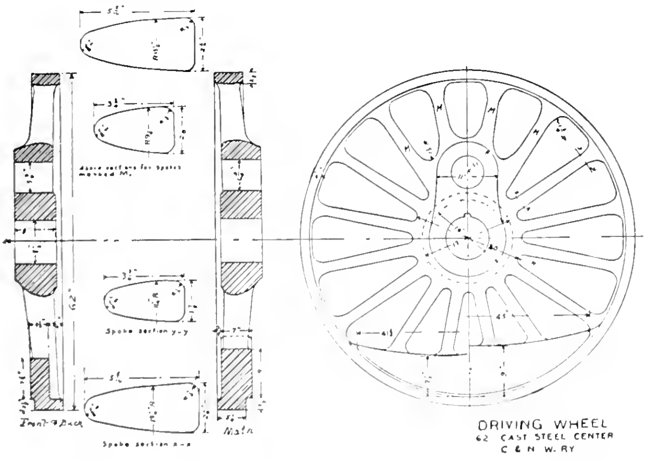
It will be interesting to many of our readers to note the terse and comprehensive formulæ for the counterbalancing of locomotive driving wheels in use in the repair shops of the Chicago & Northwestern Railway, and when the instruction cards not only completely cover detail in the general construction and repair of locomotives, but where such instructions are presented.

An abstract of the method is as follows: Balance all revolving weights belonging to each wheel, and all reciprocating weights, on one side, less the total working weight of engine divided by 400, this to be equally divided between all wheels on one side. The revolving weights are the crank pins complete with nuts and collars, back end of main rod complete, and that portion of complete side rod which belongs to each wheel. On outside hung valve gear engines the eccentric crank complete. The reciprocating weights are the piston and rod, crosshead and pin, crosshead arm, lower end of combination lever arm, combination lever link and front end of main rod, all parts to be complete. The side and main rods to be weighed complete with each bearing separately supported on round bars through the center of the bearing.

When weighing wheels, place the axles, with wheels, in proper position, so that the journals can roll on level straight edges, the crank pin nuts and washers to be in place. On the main wheels of outside hung valve gear engines both eccentric cranks must be in place. On the opposite side to the one being weighed a weight equal to the weight of the back end of the eccentric rod must be hung on the eccentric crank pin. The crank pin on the opposite side from the one being weighed should be above and in vertical line drawn through the center of the axle. Hang weights on the crank pin until the wheels are balanced and will remain in any position. They weigh all of the weights hung on the pin.

The sum of these weights should equal the required unbalanced weight, which is composed of that portion of the main rod and side rods plus the reciprocating weight which belongs to the wheel being weighed. If the sum of the weights does not equal the required unbalanced weight, at the crank pin, then weight must be added or removed from the counterbalance until the wheel does balance. The counterbalance weight should be on the outside of the wheel and as far out as rod clearance will permit, with a minimum clearance of ¾ in.

All new wheels must be balanced. Old wheels must be rebalanced when revolving or reciprocating weights are changed enough to make the required weight more than 25 lbs. too light or too heavy at the crank pin.



METHOD OF COUNTERBALANCING LOCOMOTIVE DRIVING WHEELS.

The Chilled Iron Car Wheel.

The Association of Manufacturers of Chilled Car Wheels have issued a 32-page pamphlet bearing the same title as the heading of this article. It was written by George W. Langdon, the president of the association; in collaboration with Mr. F. K. Vial, consulting engineer for the Griffin Wheel Co.

The pamphlet deals with the general subject of the manufacture of cast iron wheels through the regular processes from the selection of the metals to be used to the inspection, testing and fitting of the wheels.

In the matter of fitting it deals with that of the axle as well as the wheel. The accuracy required for satisfactory work is much greater than is generally supposed and the necessity for removing the minimum of material from the axle in order to work to the greatest economy. In regard to this the authors say:

"It has been recommended that axles on which any two diameters of one wheel seat vary more than .003 inch, or which is .001 inch out of round, shall be unfit for mounting; and that wheel bores which show more than .002 inch difference in any two diameters shall also be unsuitable for mounting. Both wheel seats of axles and bores of wheels should be gauged in three places at 1 inch from each end of wheel seat and in center.

"The greater part of the axle turning in railroad shops is for repair work, i. e., fitting new wheel to old axles or refinishing cut journals. It is self-evident that wheels must be fitted to the axle in such a manner as to preclude all possibility of becoming loose in service. This can be accomplished and at the same time the metal of the axle can be conserved. The new value of a 50-ton axle is $40; its scrap value is $8. The cost of service given by each axle is therefore, $32.

"The life of an axle is represented by the difference in diameter of wheel seat when new and when turned to limit of safety which, in axles for 100,000 pounds capacity cars, is ¼ inch. This difference in diameter may be compared to a steel tube with a wall ⅛ inch thick. A calculation will show that this metal weighs about 12½ pounds, and considering the new and scrap value of the axle, is worth about $2.50 per pound; also each .001 inch in diameter of the axle is worth approximately 25 cents. As an illustration, if one axle is turned 1/32 inch smaller than another, its value is reduced $7.50. While the diameter of the wheel seat may not always be the cause of scrapping the axle, the removal of the smallest possible amount of metal is of the utmost importance. The ques-

tion of slightly increased cost of machining should be secondary to that of saving metal.

"It is important to consider that good work cannot be done without good tools. Proper shop practice will not permit machinery to be in bad repair. The importance of true and properly fitting lathe centers cannot be overestimated, as during their life axles may be turned on a number of different lathes. If the lathe centers are not true or their angle is not uniform, it will be found impossible to do good work. An instance has been noted where a few axles were about .01 inch out of round, and an investigation showed that the lathe in which they were turned had centers with an angle of about 85 degrees, while the axles had been centered to 60 degrees. As a result the axle only rested on the lathe center at the end or had a circular line bearing. This line bearing soon wore uneven, allowing the axle to work back and forth, and was responsible for the eccentricity of the axle. An examination of the centers in axles will frequently show the result of turning on lathe centers of different angles. The axle centers will have the appearance of having been made with a very badly ground centering tool. Some shops are provided with a special grinder designed so that the centers will always be ground on a 60-degree included angle, being thus purposely made to avoid the possibility of setting incorrectly. While the saving due to its use cannot be estimated in dollars and cents, there is no question but that the better work would justify the cost, especially in the larger railroad shops. However, this machine may not always be necessary, but each shop should have center gauges, as they are cheap, and these gauges should be frequently tried on centers, and when the latter are found to be incorrect, they should be repaired at once.

"Alignment of axle lathes is also a point that does not always receive the aottention that should be given. Tapered wheel seats are often obtained on lathes on account of poor alignment and are likely to cause improper fits when mounted with wheels, which are therefore liable to become loose in service. There is also the possibility of the hubs of the wheels bursting when pressing on, and therefore alignment of axle lathes is a matter which should receive the closest possible attention in all shops. The importance of keeping a lathe in alignment can be appreciated when we consider that to mount a steel wheel having a 7-inch bore or a chilled iron wheel of the same size, the axle must be about .007 inch and .015 inch respectively larger than the wheel bore. Each .001 inch will affect the mounting pressure about 10 per cent. Wheels having been removed that had a bearing for a part of their length, owing to taper-turned axles, and while the wheels did not come loose in service, it is a condition which, if known to exist, is cause for anxiety. A very satisfactory test for lathes is to take two or three light cuts across the length of the wheel seat and measure the diameters with micrometer calipers."

Use of Pulverized Coal in Brazil.

At the semi-annual meeting of the American Society of Mechanical Engineers Mr. J. E. Muhlfeld presented a discussion of a paper on the use of pulverized fuel in which he gave some details of the work done on the locomotives of Brazil.

There are extensive coal mixtures of a comparatively low grade in the southern part of Brazil. From a study made in 1904-06 it was concluded that the native coal was unsuitable for economic use. But, owing to the high price of imported coal it was of the utmost importance to the economical operation of the railroads that this coal should be used. Accordingly an investigation was made of the use of pulverized fuel in the United States, the favorable report of which resulted in the installation of a 15-ton per hour fuel preparing and coaling plant by the Central Railway of Brazil, and the decision to equipping 250 existing and new locomotives with the "Lopulco" system of the International Pulverized Fuel Corporation of New York. A number of tests have been made with the first locomotives equipped, that have been very successful, full boiler pressure having been maintained throughout the runs.

Coal from three localities has been tried and one grade of lignite. The average analysis of the three grades of coal is as follows:

Moisture	7.93 per cent.
Volatile matter	29.80 " "
Fixed carbon	43.07 " "
Ash	19.20 " "
	100.00 " "

The average number of thermal units per pound is 10,225.

The analysis of the lignite gives:

Moisture	19.00 per cent.
Volatile matter	36.00 " "
Fixed carbon	19.20 " "
Ash	25.80 " "

with 5,249 thermal units per pound of fuel.

It was only by the adoption of a pulverised fuel system that the utilization of Brazilian fuel became possible. It cannot be burned practically or economically on grates or in retorts, nor utilized to good advantage for the production of producer gas. This solution has, therefore, led to the development of the native coal fields of the country through the establishment of steamship and railway means of transportation from the mines.

Charles M. Schwab on Railroad Requirements.

Charles M. Schwab states that the railroads will require 5,000,000 tons of steel rails during the next twelve months. The deficiency during the war period from 1914 to 1918 inclusive was 3,825,000 tons. The deficiency has continued during the present year. When the heavy falling off in rail buying over the last five or six years is taken into account Mr. Schwab's estimate of the requirements are conservative, and it is generally admitted that the railroads will be in a crippled condition if the purchase of necessary equipment is delayed much longer.

Electric Heaters in British Trains.

The usual method of British railways for warming electric trains is by electric radiators, placed under the seats. On the London and South Western Railway the heaters are of 400 volts capacity, and one is placed under each seat. In practice, however, the temperature is raised sufficiently by the use of one heater in each compartment, save when the weather is exceptionally cold, when the radiators under other seats are put in operation.

Lima Locomotive Works.

Extensive additions are being planned that increase the capacity of the Lima Locomotive Works by at least one half. The proposed new erecting shop will afford a capacity of about 70 locomotives per month. Other new additions will be a separate shop for superheater appliances, beside enlarging the boiler and tank shops. The extensions, including an addition of new power equipment, will cost over $1,500,000. As soon as labor conditions are in a more settled state, the work will be proceeded with.

CONVENTION OF THE SIGNAL DIVISION.

The first annual convention of the Signal Division of the American Railroad Association was held in Chicago on September 17-19. Among other subjects, that of automatic train control was discussed at considerable length, the consensus of opinion being that tests should be made on a more extensive scale, and to this end the railroads should lend liberal assistance. It was also urged that a greater degree of conformity to the regulations and material approved by the division should be established. It was expected that the details in regard to materials would become mandatory, but this seems to have been very much neglected. The matter will be called to the attention of the Executive Committee of the Railroad Administration, and a marked improvement is expected.

Twenty-Fifth Annual Convention of the Traveling Engineers' Association

The twenty-seventh annual meeting of the Traveling Engineers' Association was held at the Hotel Sherman, Chicago, Ill., from September 16 to 19 with nearly 700 members in attendance. The president Mr. H. T. Henson presided.

In his opening address he referred to the war and its effect upon the property of the railways and the personnel of their employer. Adding that as the association and its members had met the challenge of war so now they must be prepared to meet the challenge of peace. He quoted certain statements made in 1869 after the civil war, regarding the unrest of labor and the almost impossibility of securing any sort of satisfactory service that might be read into the records of 1919 without the changing of a word. Now, as then, the greater portion of the trouble is due to the demagogue and the politician. And now we have the threats to modern life of a widespread unrest, and revolt against profiteering in every form. Profiteering not only on the material necessities of life but in the service needed to carry on the everyday activities of modern industry. In this labor should not act as an obstructionist to delay the resumption of the smooth flow of the works of peace, but should show itself to be impelled by loyalty to the government and to its employers. He urged the members of the association to help because of their influence. He set forth the necessity for a rigid economy in all walks of life and on every side. Much has been done, but there is much to be done. Therefore, let the watchwords be, "safety first," then co-operation between all branches of the service as the best means of attaining the ends of economy and success.

SECRETARY'S REPORT.

In his annual report, the secretary, Mr. W. O. Thompson, stated that the society had 1272 members, of whom more than 100 had joined during the past year. To this must be added more than 100 who joined during the period of the convention. The association now has $4,721.50 in available funds and no liabilities.

BEST METHODS FOR HANDLING THE AIR BRAKE ON MODERN PASSENGER TRAINS UNDER ALL GRADE CONDITIONS.

This, the first paper on the program, was presented by T. F. Lyons, the chairman of the committee and chief air brake instructor of the Lake Shore and Michigan Southern Ry. The paper opened with the preparation of the locomotive starting with the air compressor.

The first thing is to open the drain cocks and then open the valves enough to start the compressor and heat it. When the steam cylinders are thoroughly heated, close the drain cocks, quickly feed ten to fifteen drops of oil to the steam cylinders, then regulate the feed to about one drop per minute for each compressor. After obtaining about forty pounds main reservoir pressure, open the steam valve as required, then quickly feed ten drops of oil to each air cylinder.

The amount of oil required for the air cylinders is so small that the best method of lubricating them is to feed ten drops of oil to each cylinder before starting on a trip, and then feed ten drops to the high pressure cylinder only at three-hour intervals during the trip.

If water is worked, extra lubrication must be given to the steam end of the compressor at the same time an extra amount is given to the locomotive valves and cylinders.

With the engine standing and the brake handle in the release position the gauges on the main reservoir, brake pipe and equalizing reservoir should indicate the same pressure. A variation of three pounds should be reported and the gauges tested.

To test the locomotive brake, apply and release both with the automatic and independent brake. Note the piston travels on engine and tender and see that the pressure regulating devices maintain the specified pressure within three pounds.

The following pressure regulating devices should be adjusted to the estatblished pressure standards and should be tested: The feed valve, with the automatic brake valve handle in running position. The reducing valve, for proper brake cylinder and signal line pressure, with the independent valve in slow application position. The excess pressure governor head, with the automatic brake valve handle in running position. The maximum pressure head, with the automatic brake valve handle in lap position. The safety valve on the distributing valve, with the automatic brake valve handle in emergency position. Move the brake valve handle to lap position if the safety valve does not control before the pressure exceeds eighty pounds. Also note when safety valve closes on return to lap position.

Before coupling to train, open the compressor steam valve wide, increase the steam end lubricator feed to about two drops per minute.

To charge the train quickly, use release position until five pounds less than standard brake pressure is shown. The application for the terminal test of the brakes may then be made.

To make the standing brake test make a twenty-pound continuous reduction and hold the brakes applied until the inspector has examined the brake on each car to see whether it is applied and has correct piston travel. Then release the brakes. When the rear brake releases, the one inspecting should examine each brake to ascertain whether all have released.

If, for any reason, an angle cock or double-heading cock have been closed at any time, insure that all such have been reopened by making an application, getting a signal that the rear brake has applied, then releasing and receiving signal that the rear brake has released.

The running test is made by the engineman making an application that will satisfy him that the brakes can be operated from the brake valve, and if he finds that they cannot be, must at once signal for brakes.

On stopping at terminal leave the brakes applied with a reduction of 20 pounds.

To avoid starting quickly, slipping drivers and taking up slack harshly do not open throttle until the brakes are released. Then open gradually with cylinder cocks open if possible. Where failure to start requires the taking up of slack close the throttle, apply the independent or straight air brake, reverse the locomotive, then graduate off the engine brake. Use steam, if necessary, to close in all train slack. Make a brake pipe reduction of six or eight pounds. Continue to work steam moderately until stop is completed so as to have all slack closed in. Reverse the engine, start the release of the brakes, and, at the time when experience indicates that the holding power of the rear brakes is ending, promptly use steam, but as carefully as consistent with starting the train and avoiding damaging shocks.

Do not use the independent brake in making passenger train stops. It should be applied and left in application position to prevent the locomotive from moving while taking coal or water, etc. When releasing the independent brake, move the valve handle to running position only. If the engine brake does not realse, make a "kick-off" with the automatic brake valve.

Smooth handling of passenger trains requires that slack must never be changed suddenly. The action of the brakes in changing the slack will be most severe at low speeds. Therefore, avoid any heavy reduction when speed is low.

To brake successfully, observe the air gauge.

Do not use sand while braking on good rails, except in an emergency. Use sand to prevent wheels sliding on slippery rails. Start it flowing before the brakes are applied in service braking, and immediately after the brakes are applied in emergency braking, continuing its use throughout the stop.

To completely release passenger train brakes, move the automatic brake valve handle to release position, back to running position, and then, after waiting about seven seconds, make a "kick-off." The proper length of time in release position is indicated when the brake pipe hand shows at least five or six pounds more after returning to running position than before moving from lap to release, and will vary from a second with a very short train to not more than fifteen seconds with the longest train.

The kick-off consists of moving the automatic brake valve handle from running position to release position for a second and then back to running position.

The split reduction consists of dividing into two or more reductions, with a little interval between, a number of pounds, that if drawn off in one continuous reduction would cause harsh slack action. When the reduction is completed, it will be the same throughout the train, causing the rear brakes to increase in holding power to that of the forward brakes.

Pre-releasing is starting the release of the train brakes just enough before the stop is completed that they will be almost off at the stop so as to avoid the shock that will follow holding a more or less heavy application until stopped. Trains of eight cars or more must be brought to a stop before brakes are released. If the application is less than ten pounds below the maximum brake pipe pressure, increase to at least that amount after stopping before releasing.

Graduated release consists of releasing the train brakes in steps or graduations, as can be done with the L-N equipment, or with the P-C or U-C equipment when operating in graduated release position, but not with the older or P-M equipment. It is accomplished by increasing the brake pipe pressure enough to move the triple valve parts to release position, then stopping the flow of main reservoir air to the brake pipe by lapping the automatic brake valve.

From other than low speeds make the graduated release stop as follows: While working steam, make a brake pipe reduction of about fifteen or eighteen pounds, using the split reduction. Then, gradually reduce to a drifting throttle. Make this application so as to have the speed down to twelve or fifteen miles per hour when about 500 feet from the stopping point. Now, by two or three graduated releases so complete the stop as to have but a light holding power or none, as required when the train is at rest. Make the first graduated release by using release position for a second or two, then back to lap. Do not attempt to make any further graduated release when the brake pipe pressure has been restored to within five pounds of the maximum pressure. Avoid graduating the brakes off sufficiently to necessitate a re-application at low speed, as to do so will cause a severe shock. Where a low speed stop is required, do not attempt a graduated release unless the brake pipe pressure has been reduced more than ten pounds. The instructions to use release position for the first graduated release apply only to trains of over five cars.

Stopping without graduated release from usual speeds requires the two-application stop. For the second application make a reduction of about seven pounds, and follow with a little more when necessary, but endeavor to avoid a total of over ten pounds. At the proper time, depending on whether the train consists of less than eight cars, release the brakes by using release position, then running position, followed by the kick-off.

When making stops from low speeds, allow sufficient time between shutting off steam and starting the brake application to permit the drawbar springs to re-act and start the slack in. The effect on the slack is stronger at slow speeds. Therefore, the two acting together will produce very disagreeable shocks. Where the one-application method is being used, make a split-reduction.

In an emergency, move the brake valve handle quickly to emergency position and leave it there until the train stops.

Retaining valves should be used when descending mountain grades whenever the brakes cannot be re-charged to within ten pounds of standard pressure. When operating with retaining valves, be sure that the application is sufficient to insure a release, so that the train is retarded by the retaining valves, and not by sticking brakes. Graduated release must not be used when retaining valves are cut in.

The automatic brake valve on other than the head locomotive must not be cut in except for an emergency application which the head engineman is unable to make when backing. If the train is to be controlled by the backup hose, the man at the rear will first make an application of the brakes. The engineman will then release the brakes and start to back. Then, when making the backing movement the brake valve is to be kept in the running position.

To slow down make a seven pound reduction, followed by further reductions, to obtain the desired speed. To insure a prompt release a reduction of at least 10 lbs. should be made before releasing.

If stuck brakes are noted on a running train that is fully charged, the surest way to release it is to make a reduction of ten pounds, wait until the service exhaust ceases, then make the regular release, followed by the "kick-off." If an application is impracticable, "kick-off" carefully—not long in release.

If a train of the older or "P-M" equipment is overcharged while running, the pressure can be reduced to the standard by applying and releasing the brakes one or more times without much re-charging.

With the "L-N" equipment an overcharge of five pounds may be got rid of by reducing the brake pipe pressure to sixty pounds and releasing. The engineman should not attempt to control a train for long distances by graduating the brakes with a partial release, because brake cylinder leakage, where existing, will cause the brake cylinder pressure to reduce considerably, thereby overworking the brakes on other cars. The brakes should be fully re-charged following every second or third graduation, or oftener if it is found that the brake pipe pressure is reduced considerably by the time a release takes place.

The failure to use the retaining valves on baggage or mail cars, may result in the over-working of other brakes on the train, and cause excessive heating of wheels and shoes.

Discussion: The reading and discussion of this paper occupied the whole of the first day.

The discussion opened with a criticism of the suggestion to make a split reduction with graduated release while working steam, and there were a number of objections raised to such a practice on the ground that it was a waste of fuel, though it was understood to be advocated because of the control of the slack action which it afforded.

The use of the throttle during the period of application received considerable attention. It was suggested that a smooth stop could be readily obtained on a heavy up grade by using a full throttle up to the stop, but that on the down grade the drifting throttle only should be used. The use of the drifting throttle came in with the introduction of superheated steam, and was used to get away from the flashing of the oil in the cylinder and to cool the same. A point, in this connection, that must receive attention is the character of the throttle. If a cracked throttle is to be used, it should be so constructed that it will stay cracked and not be necessary for the engineer to hold it in position. Also, there should be some means for the engineer to know when it was cracked.

There was also an objection to opening the compressor wide before coupling

to the train, because, with an empty engine racing would be the sure result, which would be very bad for the machine.

In regard to a recommendation that the speed of trains on 2½ per cent. grades be set at 45 miles per hour, there was a good deal of argument pro and con.

The cons argued that it was a dangerous speed. The pros replied that the danger was merely relative. That the sole point lay in the distance required to stop. That 45 miles per hour was no more dangerous, so far as that was concerned, than was 65 or 70 miles an hour on a level.

Bad lubrication of the steam cylinder packing was charged, with water in the brake-pipe. Under conditions of bad lubrication the packing would be worn and the leakage would run down the rod and work its way past the packing into the air cylinder, whence it would be discharged into the main reservoir, and might find its way back as far as the last car. The right feed lubricator was recommended for the single stay compressor, but not for the compound, because oil is apt to fill up the crossover pipe.

The lubrication of the air cylinders was acknowledged to be a very important and difficult thing to accomplish. A method in use on the Northern Pacific was highly recommended. It consists of discharging the oil into the cylinder in an atomized condition.

The method consists of using the lubricator to deliver the oil to an orifice and blowing it into the cylinder with compressed air. This atomizes the oil and causes it to spread over the whole inner surface of the cylinder. This will stop a pump from groaning at once. On the other hand, if an attempt is made to stop a pump from groaning, the desired object will not be accomplished until too much oil has been fed in. The best results are obtained by feeding ten or twelve drops at the start and then three or four drops, two or three times, in running over a division. The main difficulty, however, is to lubricate the high pressure cylinder, and for this no entirely satisfactory method was suggested.

The emphasis placed in the report on the importance of preparing the locomotive for a run was supplemented, in the discussion, by urging it to be of equal importance to prepare the cars. When trains are found with piston travel varying from 2 ins. to 11 ins., satisfactory braking cannot be accomplished. With a train in such a condition no engineer should be held accountable for bad handling, as it is impossible to do good work with widely varying pressures in the cylinders. Then there are many officers' cars that have excessively large auxiliary reservoirs which tend to put unequal pressures in the cylinders.

The question of variations of piston travel is also of importance on wooden cars, especially where automatic brake slack adjusters are in use. There is more yielding to the frames of wooden cars than there is to steel and the increase of the running over the standing travel is much greater. There is also apt to be trouble with the slack adjusters, which are apt to cut down the piston travel on wooden cars, and by that very act cause an increase of cylinder pressure to be developed, which, acting in a cycle, still further exaggerates the trouble. Cases have been known where the slack adjusters have cut piston travel down from 8 ins. to 4 ins. on a single trip.

Cylinder pressures are also frequently increased by the feeding up of the triple valves when used in a graduated release, whereby the braking power of cars is increased after the engineer's valve handle has been placed in lap position.

It was recommended that a split reduction be used in applying brakes on trains equipped with mixed triples. This gives the slowly acting valves to get to work before the full braking pressure is applied and thus avoids the shocks that would otherwise be developed.

It did not appear that the troubles already existing would be decreased in the future. There has been and will continue to be a tendency to increase the length of passenger trains and trains of from eighteen to twenty cars were predicted for the future. Then, in order that the handling of trains may be smooth a long piston travel will be needed so that the pressures may be built up gradually and thus avoid shocks while the impulse is traveling from the front to the rear end of the train. In short, the only way to avoid shocks on long trains is to use a split reduction in making a brake application and having a long piston travel so that the cylinder pressures may be built up gradually. It is, however, difficult to get an application through a long train with a light reduction, so that if these conditions were to be exacted it would mean a slower schedule. What is needed is that these requirements should be provided for automatically.

It was urged again and again that a uniform piston travel was the best safeguard against shocks, and that where orders were extant fixing the piston travel at from 7 ins. to 9 ins., or even from 7 ins. to 8 ins., shocks would be sure to occur.

Again, shocks on long trains are very apt to occur where a stop is made with the independent brake and the use of this should be avoided. Nor should the independent brake be used in making a running test, because what the engineer wants to know is how the brakes on the train are holding and this is impossible to determine if the independent brake is used; because some cars might even be cut out and no indication of the fact be given to the engineer.

Wet steam in the air pump was attributed to the long and exposed connections that are sometimes used, and it was suggested that they be put under the jacketing. This has been done in some cases with very good results, and with no trouble from corrosion. It was once thought that copper pipes were a necessity, but this is not the case, as galvanized iron has been successfully used.

The practice of locating cut-out cocks 25 feet or more from the triple valves was condemned, and as a last word on shock it was held that they are frequently caused in a two-application stop by hold on the first for too long a time.

Freight Train Tonnage Rating.

This paper was presented by the chairman of the committee, H. C. Woodbridge, of the United States Railroad Administration, and opened with a quotation from Prof. W. J. Cunningham in which it was urged that the ultimate unit of freight car efficiency is not ton miles per day. The paper then went on to urge that a considerable economy could be effected by even a slight increase in freight train speeds. Fuel consumed per ton mile is reduced as loads are increased, but wages are usually increased. So while tonnage rating by the use of the dynamometer car is highly scientific and produces good results, there is danger that an operating official may lose his balance and overload to an unprofitable extreme.

The probability of costly delays and accidents increases very rapidly as the length of train approaches the present maximum, because the modern locomotive can keep a train in motion that it cannot start. Hence, when starting is necessary the slack must be run out with such force as to overstrain even the best draft gears and couplers.

The modern locomotive attains its maximum fuel and thermal efficiency at speeds of not less than twelve miles per hour while working at approximately 25 to 30 per cent. cut-off. As the cut-off is increased, the thermal efficiency decreases rapidly. At lower speeds, high degree superheated steam is not obtained, and the possible economy from this source is not realized.

Again, there is a psychological effect of delays that cannot be overlooked. Delays or depressingly slow movement exhaust patience and interest, and without interest and initiative on the part of engine and train crews the best performance cannot be obtained.

Aside from the psychological effect on

employes—the time element in calculation of wages of train crews, at one time negligible, has become of great and increasing importance during the past few years.

On a railroad handling many high-speed and important passenger, express and mail trains on the same tracks that are used by freight trains, the maximum possible tonnage per train will result disastrously; while on roads having four tracks a closer approximation to maximum tonnage can be maintained.

This means that local conditions govern the tonnage for freight trains which must be solved for each division or district by itself.

The dynamometer car or testing plant should be used to determine whether the locomotive is properly designed and constructed, but tonnage rating should not be determined solely by the use of data thus obtained. Then allowance must be made for locomotive defects, varying efficiency of engine crews, and all the other conditions that go to affect the operation of trains.

We believe that with very rare exceptions an average speed of more than twelve miles per hour for tonnage freight trains can be attained and maintained without reduction in the properly determined maximum allowable tonnage, and that this tonnage will exceed the present rating in some instances.

The paper closed with a tabular statement of the monthly average speeds of freight trains on twenty-three railroads for the period from August, 1918, to May, 1919. These speeds ranged from 8.2 miles per hour on the Pennsylvania Lines West in August, 1918, to 15.6 miles per hour on the Union Pacific for the same month, with an arithmetical average of 10.8 miles per hour for all of the roads during the whole period.

Discussion: The discussion was opened by a statement of how the average time consumed in getting over the road has been decreased on the Philadelphia & Reading Railroad by the reduction of delays. The following is an abstract tabulation of the statement:

1918. No. Cars.	1918. Time.	1919. No. Cars.	1919. Time.
60	6 hrs. 47 min.	77	4 hrs. 58 min.
77	6 " 15 "	80	4 " 58 "
61	10 " 27 "	74	7 " 11 "
58	10 " 15 "	81	7 " 58 "
66	9 " 57 "	90	6 " 23 "

In this corresponding trains are placed in a line and the number of cars in the train with the time occupied between terminals is given. From which it appeared that dragging tonnage over the road is not all to which attention must be paid.

Some figures were also given of certain tests made on the Chicago & Northwestern to determine the comparative costs of hauling different tonnages. Two trains were used for this purpose. On one the train ran 121.03 miles in 11 hours 6 min., of which 2 hours 49 minutes were delays. The train weighed 3,001 tons; 36,286 lbs. of coal were burned, and the wages paid to the crew were $45.63. To this must be added 11,800 lbs. of coal burned by a pushing engine which was helping the train for 2 hours 51 minutes at a prorated wage cost of $12.36.

The second train ran 120.86 miles in 9 hours 51 minutes, with 2 hours 29 minutes delays. The train weighed 2,624 tons and the engine burned 32,262 lbs. of coal. The crew's wages were $39.56 and the pushing engine burned 8,700 lbs. of coal, with a wage cost, as before, of $12.36.

On trip No. 1 the average speed was 10.9 miles per hour, or 14.6 miles deducting the time of delays. The work done was 43,850 ton miles per hour.

On trip No. 2 the average speed was 12.27 miles per hour, or 16.4 miles deducting delays, and the work done was 32,000 ton miles per hour.

On test No. 1 the coal cost was $80.88 and the wages $57.99. On test No. 2 the corresponding costs were $69.08 for coal and $51.92 for wages, from which it appears that coal is the principal item of expense in train operation.

The cost of hauling 1,000 tons one mile was 38.2 cents on trip No. 1 and 38.1 cents on trip No. 2.

So that the actual cost was about the same. But taking the time on the road and assuming that it would have been the same on the return trip, and allowing 9 hours for terminal delay and work, it appears that the engine with the first train could make a round trip in 40 hours or 18 round trips per month. The engine of the second train could make a round trip in 37 hours 30 minutes, or 19.2 round trips per month. On the first train this would have given 736,000 ton miles times 18, or 13,248,000 ton miles per month, while the second would have given 634,000 times 19.2, or 12,272,800 ton miles. So that while the actual cost per ton mile would have been the same for the two methods of loading the actual net revenue per month to the railroad company would have been the greater with the heavier loading.

The matter of reduction of delays received the major part of the attention. In the case cited it was found that the second train pulled harder per ton than the first. One road found it possible to cut the time in two by reducing the number of stops and reducing the time spent at those which were made. From which it was argued that the tonnage was pretty well adjusted.

It was also urged that to haul less tonnage per train and do it in less time was an economic advantage. A case was cited where a train requiring one helper over a ruling grade could make a round trip in 16 hours where a two-helper train required 12 hours for a one-way trip.

But it was acknowledged that, taken as a whole, there was a general sentiment in favor of heavy tonnage. On the other hand engineers do not like to haul heavy trains, and this feeling is shared and emphasized by the fireman. Yet, while they do not like heavy tonnage trains, they make the best of them when they get them. A case was cited to this effect where the tonnage on a certain division had been increased from 1400 to 1600 tons with no objection on the part of the men. It is not so much the heavy tonnage that the men object to as it is the unnecessary delays to which they are subjected on the road, and for this the responsibility was put upon the train despatcher. As an example a case was cited where a train had to stop for a railroad crossing and was stopped again six miles beyond for an order. The order ought to have been at the crossing and the second stop avoided.

The sum and substance of the whole discussion lies in the statement that no fixed rule for tonnage rating can be laid down, because it must be governed by local conditions and these are ever variable and subject to change.

One speaker rather decided the test train is that, due notice having been served that it was to run everybody concerned was keyed up to look after it, and, as a consequence, it was almost impossible to have one that represented the real everyday conditions on the road.

ADVANTAGES OF MECHAICAL STOKERS.

In the first place, the advantage to be gained is the realization of maximum boiler efficiency, not only through sustained periods, but at any time when needed, which will occur at times in any territory regardless of physical conditions. The necessity for using mechanical devices wherever possible, not only from a humanitarian standpoint, but years ago the capacity of the fireman governed the amount of work done and not the capacity of the locomotive. This meant a frequent loss of otherwise available power. The stoker does away with all of this and, with proper maintenance, makes it possible for every engine to be 100 per cent efficient.

While the stoker is not automatic and requires intelligent handling, there can be no question but that there is a much larger field for fuel economy in its use than there has ever been in hand firing. The science of firing should be reduced to a mechanical instead of a human operation and the physical human equation

almost eliminated. This not only makes it possible to make all our power do the work it was designed to do, but do it in the shortest possible time.

Every railroad official knows that it is only occasionally that a fireman can get 100 per cent of efficiency out of the locomotive. So that it is fair to assume that the work done in any given territory will be based on the average poorest fireman instead of the average best. Whereas, with the engines equipped with mechanical stokers, receiving proper attention at terminals and by the men on the road, each will give identically the same service.

Then again it would seem that the steam chest temperatures in connection with superheated engines should receive much more attention than they have had in the past, and there is no question that a scientific job of firing largely affects steam chest temperatures when using superheated engines.

The stoker also makes it possible to carry the water at a lower uniform level than is possible with a hand-fired engine, for the reason that the steam pressure can be maintained at any time even though the engine is being worked to its maximum capacity through any sustained period.

No definite conclusion has yet been reached as to fuel consumption, but from the increase of boiler efficiency, and the possibility of reducing the time between terminals it would seem that the present perfected form of stoker should effect a very material reduction in fuel consumption based on the consumption per ton mile per hour.

In all the comparative tests that have been made between the stoker and hand-fired engines no one seems to have come to the same definite conclusion regarding fuel consumption, but from our experience we have found that in using the same grade of coal with the stoker and hand-fired engines, the boiler efficiency of the engine not only is increased to a great extent as far as handling tonnage is concerned, but that it makes it possible to very materially reduce the running time between terminals; therefore, with the present stoker in its perfected form, it should not only show much greater efficiency than a hand-fired engine, but also effect a very material reduction in fuel consumption, based on the consumption per ton mile per hour.

While it is possible to educate any body of men to operate the stoker so that we will get identically the same result, it is certainly impossible to educate any body of men to fire an engine by hand identically the same.

There seems to be considerable stress placed on the stack losses of some stoker-fired engines due to the extremely fine quality of coal necessary to use on them. While it is true that in the past considerable loss occurred from this source, with the present stoker perfected as it is, and the brick arch extending well back to the door sheet, we find that the stack losses can be reduced to a point nearly as low as is done by using run of mine coal hand-fired. So that by a proper construction of the firebox and brick arch it should be possible to burn 98 per cent. of all the fuel in the firebox.

As to the cost of maintenance of the stoker, records for the past five years show this to have been a little under $10.00 per thousand miles. In regard to miles per engine failure records on one road show them to average one failure for 61,556 miles run.

And finally the stoker has almost entirely eliminated the reports of engine failures because they did not steam properly.

To sum up: In the opinion of your Committee the application of the mechanical stoker to present-day locomotives makes it possible to obtain the full efficiency out of both locomotives and men, at any and all times.

The possibility of carrying a low water level results in better valve and cylinder lubrication, thereby reducing maintenance costs.

Regular firing with a closed door results in higher steam temperatures, reducing the fuel and water consumption.

Correct application of the brick arch reduces spark losses to a minimum.

A standard unchangeable front end can be maintained, eliminating the cost of continual adjustments.

Inferior grades of fuel can be successfully burned.

And last, but not least, let us not forget that the fireman of today is the engineer of tomorrow, and owing to the constantly increased coal burning capacity of the locomotive, the application of a mechanical means of supplying the fuel is the only thing that will make the work sufficiently attractive to enable us to get and keep the right kind of timber on our engines.

The report was presented by E. Gordon, chairman of the committee and master mechanic of the El Paso & South Western Ry.

Discussion: The discussion opened with a question about and a brief description of the operation of the Elvin stoker on the Erie railroad. From what was said it appears that the machine is operating in a very satisfactory manner, as regards elimination of smoke, maintenance of steam pressure and running with 100 per cent. stoker firing. But when the question was asked as to whether, when a bank formed in the oval bed, it would be possible to divert the distribution of coal away from that point until it had burned out, the question was avoided or misunderstood. At least it was not answered.

The necessity of educating the men in the use of the stoker was emphasized but that this was much easier of accomplishment than to train a man to do good hand-firing was allowed. One speaker was very emphatic in his statement that a stoker fireman could be trained in three days and challenged any member of the association to put him to the test. Another who said he knew all about the geology of coal and the chemistry of combustion claimed that no man could be a good fireman unless he knew these things, and that they could not be learned in three days. But in the final analysis the success of a stoker depends upon the man who manipulates it, and it is on him that it depends as to how far an engine can run continuously.

As for the man to be trained it is much easier to make a good stoker fireman of a new man, who has had no experience than it is of an old fireman. As an example of this the experienced hand-fireman is accustomed to working with a thick bed of fire whereas, with a stoker, the best results are obtained with a thin bed and to get a man to change from one method to the other is a very difficult matter.

But, given the proper man, a stoker can be made to do about anything that is wanted of it. Among other things there is the elimination of smoke, which can be accomplished by a proper manipulation of the stoker. And these things cannot be done without a good man for the intelligence of the man can never be reduced to a purely mechanical operation. But though the man behind the gun may be able to do much and may mean much he cannot do everything. The mere fact that a locomotive has been fitted with a stoker is not all. The application must be properly made and the locomotive adapted to its use. For instance the drafting must be properly done and adapted to the coal that is to be used.

It is not fair to the stoker to use an inferior coal and make a comparison with a hand-fired engine using a superior grade of coal. But, while it is not recommended that it should be done an inferior grade of coal can be used. Take the Montana coal, for an instance. It is high in ash and of a poor grade, yet it can be handled successfully by stokers, and much more so than by hand-firing. In a general way it may be stated that it is the price of fuel, all things considered, that must govern what is used. One of the advantages of the stoker is the possibility of making longer continuous runs than with hand work, not only because, in the latter, the physical endurance of the man is more rapidly exhausted but because the firing can really be

more scientifically carried out. As to what that may be depends on conditions. Under some circumstances engines have had to be stopped to have the fire cleaned fifty miles from the start, or they may be run three and four times that distance. As for economy of coal the stoker affords a better opportunity than hand-firing. In some rival runs on the Baltimore & Ohio, one run of 256 miles was made in twelve and a half hours, hauling 97 loaded and two empty cars on a single tank of coal, and this was duplicated in a run of 259 miles on a single tank of coal in which the coal consumption was 23.6 lbs. per 1,000 ton-miles. Runs of 168 miles with 95 cars were also reported. It is such performances as these that indicate the possibility of lengthening divisions, and of doing away with the necessity for stops.

It may be that the stoker burns more coal than the hand-fired engine, but it also does more work, and the engine does not fail to steam because of the stoker's ability for long and sustained work. And that, too, with great economy of action, because it seems reasonable that a better utilization of the heat will result where the fire door is kept closed than where it is being constantly opened and the firebox cooled, as in hand-firing.

Incidental to the amount of coal burned it was stated that it had been found that the maintenance of a high superheat temperature of 650 degrees took more coal than 600 degrees. The use of the stoker had moved the coal burning locomotive up to an equality with the oil burning, in that it had a tendency to reduce the expensive terminal charges. And it seems possible and even probable that the successful application of the mechanical stoker, the pulverized fuel burner and the oil burner will result in the development of a new type of locomotive.

As to the class of engines to which stokers should be applied it was thought that the request of the firemen that they should be put on all locomotives weighing 200,000 lbs. or more was not always a reasonable demand. It was maintained that it is no hardship for an able-bodied man to fire an engine of 40,000 lbs. tractive effort, but that engines of 50,000, 55,000 lbs. or greater tractive effort should be equipped with a stoker.

LOCOMOTIVE EFFICIENCY AND FUEL ECONOMY

The paper opened with the general statement that proper design, proper operation and proper maintenance were the essential requisites for locomotive efficiency, and then went on to enumerate nearly all the details on the locomotive as those that should be properly designed. It opposed the pooling of locomotives as detrimental to economical operation and criticised poor terminal facilities as effecting the same result. Water supply should be looked after most carefully and where it is possible to discard a poor water and substitute a better it should be done, because by so doing or by the treatment of all bad waters, engine failures due to leaking can be reduced to practically nothing and staybolt trouble can be reduced to a minimum.

In order to get the best results in so far as fuel consumption is concerned it was recommended that a general fuel officer should be appointed, and that he should have divisional fuel supervisors whose principal duty will be the education of firemen in the economical firing of engines.

Co-operation with the operating department is very essential and monthly divisional meetings should be held which should be attended by all interested officials and employes.

Any progressive movement must be backed by educational efforts and great stress is laid on the necessity of constant education of enginemen as they are most responsible for the coal pile.

The report was presented by J. B. Hurley, chairman of the committee and general road foreman of engines and fuel supervisor of the Wabash Ry.

Discussion: The co-operation of all concerned in the use of fuel is absolutely necessary to the securing of the best results; and, that this may be done, it was urged that the making of an immediate record of coal consumption should be arranged for. That is, as soon as a run is completed a statement of the coal consumed, ton-miles hauled and other items connected with the engine performance should be made. This should be posted and, if done, will act as an incentive to better performance. Such a system is in use on the Erie railroad which takes into account the miles run, the tonnage hauled and the coal used. As it is now made out it is not exactly fair because it only takes the road mileage into account whereas the switching mileage may, at times, amount to from 25 to 30 per cent. as much as the road mileage. It is the intention to incorporate this switching mileage in the report in the near future. The report is made out immediately upon the arrival of the train at the terminal. Such a report tends to lessen the uncertainties as to the reasons for the variations in fuel consumption that some times seem so mysterious. But this uncertainty is often caused by other uncertainties, as for example, that of the amount of superheat in the steam, and this is, in most cases, a matter of the purest guess-work. To avoid such guess-work and give the engineer an opportunity of knowing as much as possible as to what he is doing, the tanks have, in some cases, been calculated so that he can tell as to just what his coal consumption may be.

To have the enginemen posted as to what they are doing in this and other respects involves an educational campaign and this is a profitable investment, for it is surely better to post a man, early in his service, as to the proper methods of burning coal and using steam than to let him find it out for himself, if he ever does, by the slow and expensive process of wasting thousands of tons of coal in the meantime. And then, when the instruction has been imparted and absorbed it must be followed by constant supervision, because few men will live up to even their own knowledge if they are not looked after.

Of the two it is of more importance to educate the engineer than the fireman, because he is in control on the engine, besides being the ultimate consumer and can govern the actions of the fireman to a great extent.

A good deal of emphasis was placed on proper engine inspection which is often slighted and in the selection of inspectors which is neglected still more. The practice of taking a machinist from the shop and making an engine inspector of him was roundly condemned on the ground that such a man, having had no experience in engine operation, does not know how to inspect, where to look for defects and, frequently even to recognize them when he sees them.

The power reverse gears got pretty severe criticisms, on the ground that they do not hold the gear at the points at which they are set, but crawl and so vary the point of cut-off and other valve events that accurate adjustment and careful use of steam is impossible. Some of the trouble was thought to be inherent in the gears themselves, and some in the fact that they are not properly maintained. One speaker estimated that the power reverse gear used twice the quantity of coal that would be used were careful adjustments possible. The matter of actual fuel saving received its due attention and the point of the high cost of fuel, being twice what it was three years ago, was repeatedly called to the attention of the meetings.

The ash pit was held responsible for a great deal of fuel waste. The men employed at the ashpits are usually foreigners who cannot understand English and it is exceedingly difficult to make them understand that they are frequently wasting large quantities of coal in their methods of cleaning the fires.

The overhauling of locomotives should be regulated by the necessities of the case and not by the mileage that the machine has made. It frequently happens that a locomotive is held out of the shops for months when it is in need of overhauling simply that it may make the mileage that has been fixed for it. This is wasteful in the extreme and locomotives should be stopped when in

need of repairs regardless of the mileage that they may have made.

BEST METHODS OF CARING FOR LOCOMOTIVES AT TERMINALS FOR EFFICIENCY AND INCREASED MILAGE.

The committee assumed that a locomotive on leaving the shops is in a condition to develop its full rated capacity. Hence the question as to what are the best methods for caring for locomotives at the terminals is synonymous with that of what constitutes good roundhouse practice. This involves a caretaking inspection of the locomotive by competent inspectors; the rendering of an intelligent report by the incoming engineer; the proper cleaning of the ashpan; the inspection and making of the repairs called for by the engineer; the provision of the proper tools and supplies, and the frequent riding of the locomotive by the traveling engineer.

The engineer's report should be brief but comprehensive, and where the exact cause of the trouble is not known the report should describe how the locomotive acted with reference to it.

Reports to the effect that locomotive blows, pounds, does not steam, or air brakes do not work properly and others of a similar indefinite nature, are practically of no value to the shop force, and in some cases, particularly where the engineer is not readily to be found to describe the character of the trouble, may lead to a failure to obtain immediate relief from the condition complained of which in turn may later lead to what should have been an avoidable locomotive failure.

There is scarcely any way in which the traveling engineer can be of more assistance to the mechanical department than in instructing engineers how to make intelligent reports.

The locomotive inspection can well be carried out according to the rules of the Locomotive Inspection Bureau of the Interstate Commerce Commission, and these, when properly carried out stand for good maintenance. The inspection should be made as soon as possible after arriving at a terminal and, of course, by competent inspectors. The railroad inspection should, however, really be more thorough than laid down in the rules and should cover every part subject to wear that would interfere in any way in the efficient working of the locomotive.

A good plan is to have an outgoing inspection covering the points reported for shop attention.

If the locomotive is to remain under steam while at the terminal, the fire and ash-pan should be thoroughly cleaned, precautions being taken to prevent chilling of the flues during this process, and the front end should be cleaned of spark accumulations.

At boiler wash periods, or at least once every thirty days, the front end arrangements should be inspected, exhaust pipes and nozzle tips should be examined to see if the former is in alignment with the stack, and that the latter is free of accumulation which tends to decrease the size of the openings. Frequent inspection of the fire in the locomotive should be made at terminals and the locomotive crews be required to bring fires to terminals well burned down to avoid waste of fuel and unnecessary work on the part of ash-pit men.

The locomotive should, when possible, be washed out with hot water under sufficient pressure and be refilled with hot water after washing. This is to avoid ill effects of strains of contraction and expansion, and as an aid to preparation for service.

In bad water districts and especially where boiler compounds are used for prevention of the formation of scale, it is advisable to blow the boiler off every trip to remove the concentrates and scale.

It goes without saying that proper facilities should be furnished for doing the work.

The men in charge of the mechanical activities at terminals should be men of experience, good judgment, foresight and resourcefulness, as well as possessed of an ability to handle men.

Permitting known poor conditions to continue on the ground that the limits prescribed by the Interstate Commerce Commission rules have not been reached not only reduces the efficiency, but frequently results in failures.

Good workmanship is the predominating feature of successful locomotive maintenance. Work slighted, disregarded, or put off until the next trip, makeshift changes or repairs are great enemies of locomotive efficiency.

Failure to maintain constantly in stock the materials needed for every-day repair work is undoubtedly one of the most prolific causes of makeshift changes and repairs, and subsequent inefficiency, shop and road delays, and locomotive failures.

Periodical examinations of all working parts is also one of the most efficient methods of maintaining a high degree of locomotive efficiency.

An increase of mileage implies a greater number of trips in a given time, and this can best be accomplished by prompt and effective work at terminals thus reducing the delays at those points, and this, in turn involves adequate facilities for the prompt performance of the work in hand. It is in severe winter weather that the handicap resulting from and the delays incident to poor facilities are felt in their full force.

In a way the traveling engineer is responsible for the weaknesses of a system that involves undue terminal delays.

It is scarcely sufficient that he is able to say in explanation of poor conditions, delays and failures, that the work required to better conditions was reported. To be relieved of his share in the responsibility for poor conditions he must be able to show that he made use of all the means within his power to bring about a betterment of conditions.

In conclusion we would point out that while betterments in the methods of maintaining locomotives are constantly being developed, failure to maintain them in a reasonably efficient condition is usually due rather to failure to carry out in a thorough manner the generally accepted practices in common use, than to a lack of efficient methods.

Discussion: As the report dealt largely with inspection matters so the discussion, which lasted nearly all day, was occupied with essentially the same topic and the matter was repeatedly presented.

In the matter of fuel costs it was held that the superintendent and his staff should be made to carry the full burden of their share of the responsibility, as they are frequently solely responsible for the wastes that are occasioned by unnecessary delays. This is especially true as the result of ordering engines a long time ahead of time and then having them stand for long periods on the outgoing tracks waiting for the train to be made up.

The value of an outgoing inspection of engines to make sure that all repairs reported had been made, was emphasized by several speakers. It was not only to make sure that the repairs had been made but for the moral effect on the roundhouse men, who would do better work if they felt that they were being watched. In some cases this outgoing inspection had resulted in the setting back of a number of engines, but the necessity for this soon passed away when the workmen realized that they could not slight work that had been ordered. The point made was that this inspection should be very thorough.

There was one small item of roundhouse work that was held to be of considerable importance as affecting the attitude of the engine crew towards the work on the road. And that was the value of having the cab clean. Have the coal swept off the foot plate, the fittings wiped and the windows cleaned. An engineer and fireman getting on an engine in such condition will be more inclined to do good work on the road than if they get into a cab that is dirty and unkempt.

As for facilities, of course, good facilities are desirable, but with the proper spirit in the roundhouse force the repairs can be made with almost any facilities. And in this the traveling engineer can render great assistance by setting his standard of maintenance high and then taking the roundhouse foreman into his confidence as to how he would like to

have the power maintained, and discussing the ways and means for the accomplishment of that end. And then through the foremen getting the goodwill of the men.

REPORT ON ENTRANCE OF TRAVELING ENGINEERS' ASSOCIATION INTO AMERICAN RAILWAY ASSOCIATION.

A proposition has been made to the Traveling Engineers' Association to become a division of Section III, Mechanical of the American Railway Association of which the Master Mechanics' and Master Car Builders' Associations are the heads. A committee was appointed to consider the subject and reported that they had declined to enter the American Railway Association in the subordinate position of a division, but would be pleased to do so as an independent section. As no answer had been received to this position, no action was taken on the report except to receive it as a report of progress.

ELECTION OF OFFICERS.

The following officers were elected for the ensuing year.

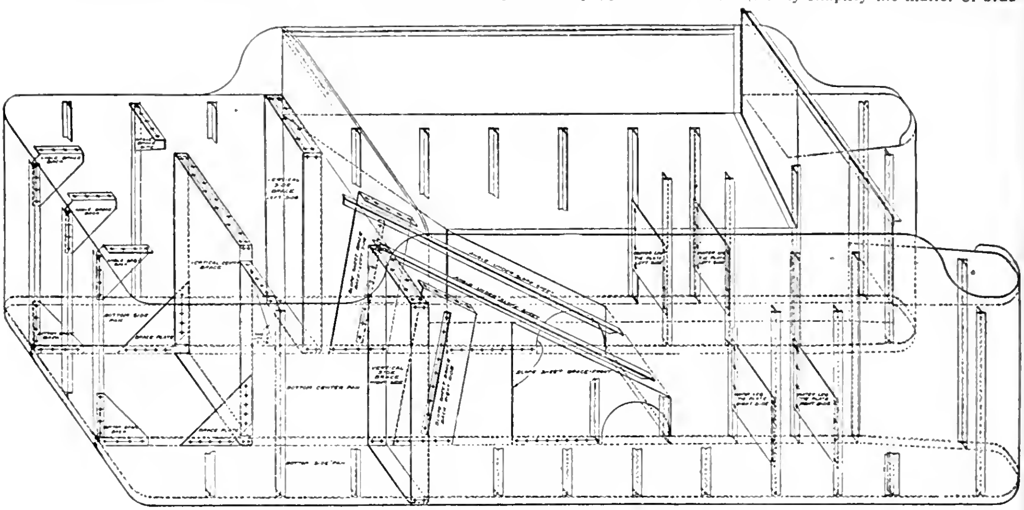
George A. Kell, Grand Trunk Railway, president; W. E. Preston, Southern Railway, first vice-president; L. R. Pyle, U. S. R. R. Administration, second vice-president; Eugene Hartenstein, Chicago & Alton R. R., third vice-president; J. H. De Salis, New York Central R. R., fourth vice president; E. F. Boyle, Southern Pacific Lines, fifth vice-president; David Meadows, Michigan Central R. R., treasurer; W. O. Thompson, New York Central R. R., secretary, and for executive committee: F. P. Roesch, U. S. R. R. Administration; Joseph Keller, Lehigh Valley R. R.; W. H. Corbett, Michigan Central R. R.; B. J. Feeny, U. S. R. R. Administration; S. V. Sproul, Pennsylvania R. R.; T. F. Howley, Erie R. R.; Frederick Kerby, Baltimore & Ohio R. R.

Bracing Locomotive Tanks.

Among the reports of committees read before the recent convention of the International Railroad Master Blacksmiths' Association the subject of "Bracing Locomotive Tanks" was ably presented by a committee of which Thomas Lewis was chairman. The committee had evidently given the matter considerable attention and the consensus of opinion arrived at was that the best method of doing the work was by the application of T bars measuring 3 ins. by 3 ins. by 3/8 in., on the sides and back spaced 24 ins. apart in a vertical position, the length of the bars to be equal to the height of the tank from the bottom to the top. These bars to be riveted with not less than 3/8 in. diameter rivets, spaced about 6 ins. apart, zigzag. The top of the tank at the rear end to be braced by T bars to the under side with gusset plates riveted on ends. The slope sheet in the coal space to be braced by two T bars riveted to the under side, also supported by stay plates placed vertically and riveted to the slope sheet and the tank bottom to be reinforced by angle bars.

Dasher or splash plates 1/4 in. or 5/16 ins. in thickness to be used for frustrating the rush of water in the tank, also forming a brace for the top and bottom of the tank. One brace is placed in the center between the coal slope sheet and the back of the tank. Two plates are placed on each side, and riveted to the top and bottom of the tank. The center dasher plate is flanged on the sides and riveted to the top of the tank. Gusset plates are also applied at the bottom and rivetted, giving added strength to the dasher plate. It is preferable that all braces should be riveted, and not bolted. The size of the rivets may be variable according to the thickness of the braces used.

This system of bracing is recommended for all rectangular shaped tanks made from steel plates of 5/16 in. in thickness or less, better service is given than by the old method of applying the longitudinal angle iron bars with cross stays. It also has the tendency to eliminate leaky rivets in anchor lugs. When weight is not limited in the design of locomotive tenders, the tanks may be made from heavier material. Steel sheets of 3/8 in. in thickness would greatly simplify the matter of bracing. However, with 1/4 ins. steel plates for tank sides and top, and 5/16 in. thickness of plates for the bottom of the tank, the method of bracing recommended renders the tank substantial in all its principale parts, and leaves space for inspection or necessary repairs.



AN APPROVED METHOD OF BRACING LOCOMOTIVE TANKS.

American Contractors Preferred.

It appears that the British Board of Trade has been questioned in regard to orders placed in the United States and Canada for railroad equipment, and the reasons for such preference as against British manufactures. In answer it was stated that some of the orders referred to were placed before the armistice, when it was impossible to supply material in Britain. It further appeared that in regard to more recent orders, especially that of locomotives, the British offers in respect both of price and the date of delivery were so unfavorable that the South African authorities felt themselves obliged to go further afield. They could not expect preference from other governments against foreign countries.

New Chart of a Pacific Type Locomotive

We present herewith, a reduced reproduction of a chart of a Pacific type locomotive which will be issued by the publishers of *Railway and Locomotive Engineering* during the current month. The illustration here used is but ten inches long, while the side illustration of the locomotive in the chart itself will be about 26½ inches long and will present the locomotive on a scale of ½ inch to the foot. The full sized chart will also carry between five and six hundred reference numbers of the different parts of the engine and a complete index of the names of these parts, so that it will form a fairly complete locomotive dictionary in itself. This is the twelfth of a series of charts that have been published by *Railway and Locomotive Engineering*, the previously issued locomotive charts being those of American, Atlantic, Consolidation and Mikado type engines.

In this case the foundation design of the locomotive was the K-4-3 class Pacific locomotive of the Pennsylvania Railroad. In the preparation of the chart the details of the locomotive have been used and drawn into scale so that the chart is not only illustrative of the locomotive, but is an assembled working drawing on a scale of ½ inch to the foot.

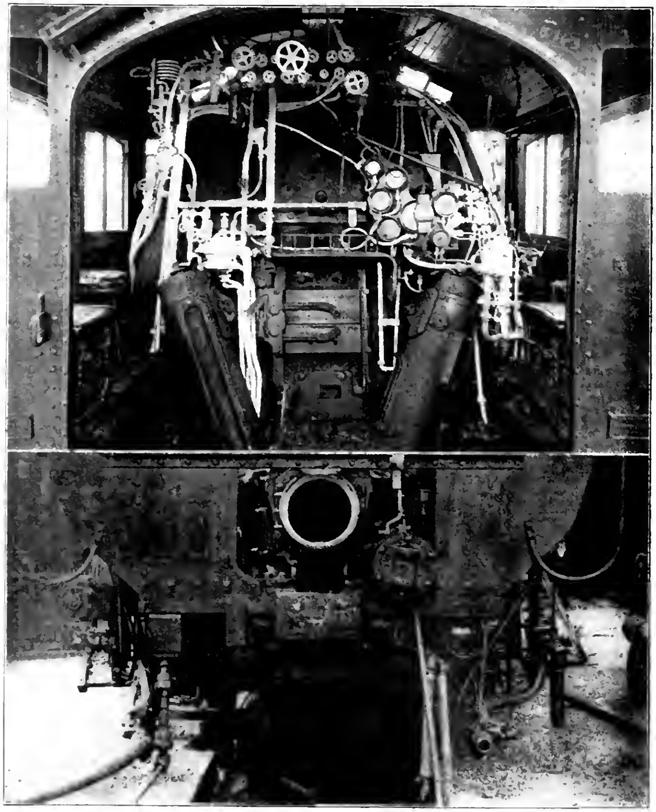
In the development of the drawing certain liberties have been taken in the original design, but these liberties in no way invalidate the value of the drawing. They refer more particularly to the specialties or locomotive appliances which do not in all cases represent the standard practice of the Pennsylvania Railroad. For example, the valve gear has been changed from the Walschaerts to the Baker. This valve gear has been applied on thousands of locomotives, is now a recognized standard on many roads, but was not shown in any of our previous locomotive charts. The same may be said of the Ragonnet Power Reversing Gear, the Duplex Mechanical Stoker, the Schlacks System of locomotive lubrication, the various refinements of locomotive construction of the Franklin Railway Supply Company, and other minor specialties which will be found scattered over the entire engine. The fundamental idea in this direction being to show the latest recognized developments in locomotive practice, a composite illustration of some of the devices that have met with general approval rather than the standard of any one road. It may therefore be considered as representative of the heavy Passenger Pacific type locomotive as used in America.

In addition to the usual longitudinal section of the locomotive which has heretofore constituted the whole chart as presented for the other designs, this chart will include a view of the back head, interior of the cab and rear view of the parts beneath the foot plate. This is something that has never been presented before, so far as we are aware.

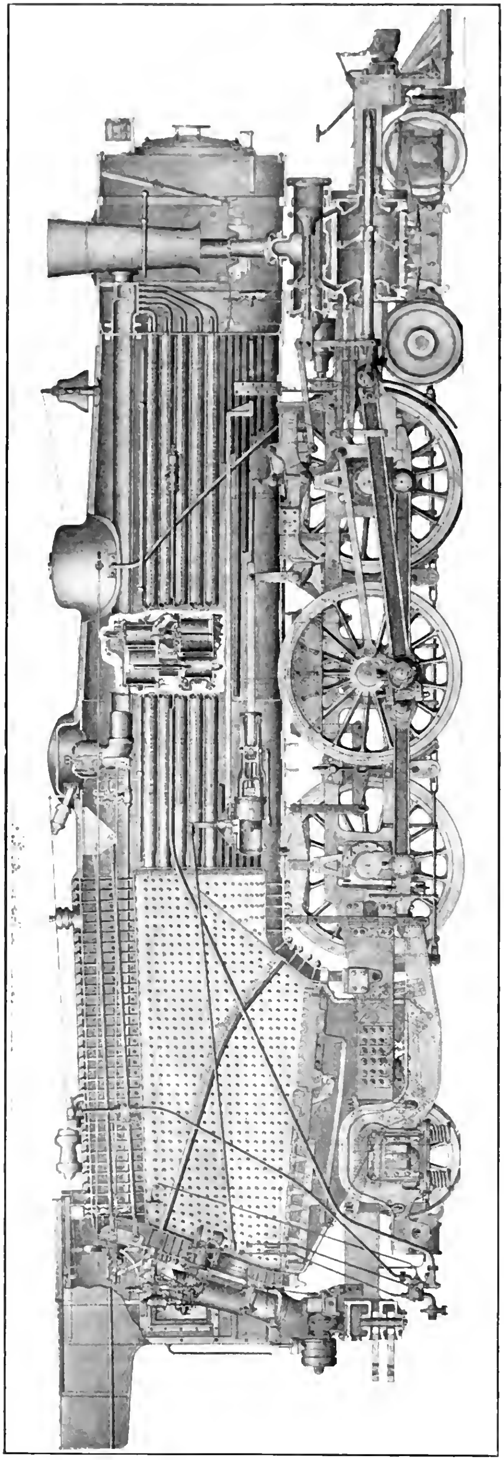
The development of the specialties that are attached to the back head of a locomotive boiler has grown to enormous proportions during the past few years until now, there is scarcely a square inch of unoccupied space on the whole surface. It is probably the difficulty of properly presenting this that has prevented such an illustration as that, which will be presented in the chart, from having been prepared before.

It cannot be claimed, of course, that this chart is a complete presentation of every detail of the Pacific locomotive which is illustrated, but it can be said that it is the most complete presentation of a locomotive of any class that has, as yet, been published on one sheet.

It may be added that the reduced illustration as shown gives only a faint impression of the finer details of the chart which as stated will be over three times larger than the accompanying photograph reproduction. We are indebted to many of the leading manufacturers of locomotive appliances for the use of the detailed drawings of their products, and in stating that it is in every way the best and most complete illustration of its kind hitherto published, we are simply echoing the opinion of a number of leading engineering experts who have taken pains to examine the work. The index embracing the numbering and naming of all of the parts, has been thoroughly scrutinized by a number of mechanical engineers of experience in such work and no pains have



PHOTOGRAPHIC VIEW OF LOCOMOTIVE BACK HEAD.
A scale drawing of this view is shown in our new Pacific Type Locomotive Chart. Each of the various appliances and appurtenances are numbered and the names given.



A reduced photographic reproduction of our New Pacific Type Locomotive Chart. This cut is 10 inches long. In the chart itself this side view will measure 27 inches alone. All parts are numbered and the names given. This sectional view with the back head view as shown on the preceding page make it the most complete thing of its kind that has ever been published. The first edition of thirty thousand copies will be ready shortly, and every subscriber to Railway and Locomotive Engineering will receive a copy.

been spared to have the finished chart absolutely correct in every particular.

The locomotives, and other charts, hitherto published by us have been received with much popular favor and may be found all over the world wherever the railroad men assemble, particularly in railroad schools and club rooms, as well as in many offices, machine shops and roundhouses, and while we have not issued any new chart during the war period, the constant demand for these charts has not only been gratifying to us as publishers, but continues to be a sure indication of the desire of the studious men in the mechanical departments of railroads to make use of this graphic method of securing information that is at once easy and complete, and the chart when suitably placed within easy reach of those interested, is of much service to an unlimited number of those seeking information of locomotive details than many text books, that are easily mislaid, and at best are usually available only to the single possessor.

It is not our purpose to belittle text-books, and in this connection and with a view of making the chart completely fulfill its educational purpose, it is our intention to take up special features of the chart, including all the principal parts of the locomotive and make of them the subject of special articles in the pages of *Railway and Locomotive Engineering*. These articles will appear serially and with enlarged illustrations of the various sections, our readers having copies of the chart will thus be furnished a thorough knowledge of the use, operation and relation of the various parts of the entire locomotive as well as the correct names of all of the various parts and appliances.

The first edition will extend to thirty-thousand copies, and a copy will be forwarded to every individual address appearing on the subscription lists of *Railway and Locomotive Engineering* as soon as it is ready for distribution.

Following are some of the details of the dimensions of the locomotive and some of the specialties that have been put upon it:

Cylinders, diameter, 27 ins.; piston stroke, 28 ins.

Diameter boiler shell, largest, 89 ins.; smallest, 76⅝ ins.

Thickness of sheets, 15/16 in. and 1 in. Working pressure, 205 lbs.

Firebox, length, 10 ft. 6⅜ ins.; width, 6 ft. 8 ins.; depth, front, 6 ft. 6¾ ins.; depth, back, 5 ft. 6¼ ins.

Thickness side sheets, ⅜ in.; back sheets, ⅜ in.; crown sheets, ⅜ in.; tube sheets, ½ in.

Water space, 5½ ins.

Tubes, diameter, 5½ ins., 2¼ ins.; No. 5½ ins., 40; No. 2¼ ins., 236; length 19 ft.

Heating surface—Firebox, 315 sq. ft.;

tubes, 3,731 sq. ft.; total, 4,046 sq. ft.; superheater, 1,720 sq. ft.

Grate area, 69 ft. 3 ins..

Driving Wheel diameter, 80 ins.

Front truck wheels, diameter, 36 ins.; rear truck wheels, diameter, 50 ins.

Driving wheel base, 13 ft. 10 ins.; rigid, 13 ft. 10 ins.; total, 36 ft., 2 ins.

Weight—Driving wheels, 201,830 lb.; front truck wheels, 56,640 lb.; rear truck wheels, 52,420 lb.; total, 308,890 lb.

Valve gear, Baker; mechanical stoker, Duplex; headlight, Pyle Electric; injector, Seller's Non-Lifting; power reverse gear, Ragonnet.

Superheater heating surface is listed at 1½ times the actual, in accordance with the practice of the Pennsylvania Railroad Co.

Report of Convention of International Railway General Foremen's Assn.

The fifteenth annual convention of the General Foremen's Association was held at the Hotel Sherman, Chicago, Ill., in the first week in September, President L. A. North, presiding. In the course of his opening address the president presented the question of amalgamating with the mechanical department of the American Railroad Administration, and recommended the advisability of revising the by-laws so as to broaden the scope of the work of the General Foremen's Association by making provision for the admission of the general foreman of the car departments. Toward this object and pending the amalgamation of the association with the other branches of the mechanical departments of railroads, already merged in the Administration's Mechanical Section, temporary committees were appointed and instructed to proceed with the necessary action in the matter. During the convention, V. R. Hawthorne, Secretary of Section III—mechanical department, instructed the members in regard to the general plan of forming the various railroad organizations into concrete bodies from which a greater degree of a unity of action and a standardization of means and methods might be confidently expected.

R. N. Ashton, director of the Northwestern region, delivered an able address bearing on the future of the mechanical department of railroads, and the uregent need of a greater degree of thoroughness on the upkeep and general repair of equipment. Much depended on the general foreman to improve conditions which the strenuous service incidental to the war period had considerably reduced. The Administration looked to the foreman, and although conditions were not what they should be, the future was full of hope, and every encouragement should be given to meetings like that of the general foremen, as they were a source of inspiration to all interested in the work in which they were engaged.

R. E. Bell, of the Safety section of the railroad administration of the Northwestern region spoke at length on the growing success of the safety movement, and the marked advantage that had been gained by the special safety campaigns that had been established on various roads. Those special efforts looking towards a greater degree of safety should be extended and the periods of united effort broadened until it became a matter of constant habit among all men in the mechanical departments, and none were in a better position to encourage the laudable object than the general foremen.

Special reports were presented on the subject of autogenous welding, and it was gratifying to observe that a large

L. A. NORTH,
President of the International General Foremen's Association, 1916-19.

number of the members showed a wide knowledge of the subject. The necessity of pre-heating in the care of gas welding was generally agreed on, and much stress was laid on the natural adaptability of individual young men to make good operators. All art may be said to be developed by experience, but a natural aptitude for such work exhibited itself very frequently and it should be looked for and encouraged. Some new points were given as to the advisability, not only of pre-heating and annealing, but of shrinking bands around the ends of thin cylinders to lessen the chance of new cracks developing in worn cylinders. The costs of the various kinds of welding brought out a considerable variation in estimates, which, doubtless a larger experience will equalize.

Draft gears also received considerable attention from a number of the members, the general opinion being that the gears did not suffer so much from organic defects as they did from a lack of maintenance in the details of the parts. Some parts of the gear have the enduring quality, while others are more readily subject to deterioration. The same may be said of any other mechanical appliance, but it would seem that the details of draft gears have not received that close attention to which they are entitled. A constant and careful inspection should be made at every available opportunity and much saving could be effected in this way. A recommendation was made that draft gears should be stencilled when applied, and conditions reported whenever removed, and that the length, width and height of gears should be standardized and so avoid the present complexity of parts which tends to confusion and disaster.

The following were elected officers: President, W. T. Gale, machine foreman, Chicago & Northwestern, Chicago; First Vice-President, J. B. Wright, general foreman, Hocking Valley, Columbus, Ohio; Second Vice-President, G. H. Logan, general foreman, Chicago & Northwestern, Chicago; Third Vice-President, N. E. Warner, shop superintendent, New York Central, Elkhart, Ind.; Fourth Vice-President, T. J. Mullin, general foreman, Lake Erie & Western, Lima, Ohio; Secretary-Treasurer, William Hall, erecting foreman, Chicago & Northwestern, Winona, Minn.; chairman of the executive committee, C. H. Barnes, general foreman, Belt railway of Chicago, Chicago.

National Association of Owners of Railroad Securities.

S. Davies Warfield, president of the above association, in the course of a statement before the House Interstate Commerce Committee, asked that the first consideration of the commission in adjusting rates shall be the amount of primary return to the railroads necessary to keep life in them, which should be a known factor, and determine this factor as a minimum and state it to the commission so that this at least may be set up primarily as an essential to the preservation of the transportation system of the country. The result would be that the first consideration would be so to adjust rates as to produce sufficient net railway operating income to let the great majority of the railroads live, and as much more as the public interest may justify: next, to ascertain what is necessary to pay a fair wage to the employes, and what is essential to buy equipment and the other things necessary for adequate railroad service which the public and shippers demand. That makes the rate. We believe practice would result in nearly an automatic arrangement in respect to the adjustment of railroad rates.

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Traveling Engineers' Convention.

The meeting of the Traveling Engineers' Association recently held in Chicago and as reported in another column, was a marked success both in attendance and the quality of the papers presented. There was a distinctive feature about this meeting that differentiates it from those of its sister associations. Evidently the executive committee has decided not to attempt more than it can accomplish and has therefore limited the reports and papers presented. Usually, and especially in the case of the minor associations there are a large number of papers on the program, more than can be successfully handled by the methods in vogue. The result is that those first presented receive an undue amount of attention which results in the skimping of the time allowed and the hasty and inadequate consideration of those that are later on the program. The Traveling Engineers seem to have recognized the fact that many of its members wish to discuss every paper, that some of those, many are rather prolix and do not always speak to the point, but, as members of the association, have a right to be heard. So early in the proceedings they voted down a proposition to limit all debate to five minutes and threw the doors wide open to all comers. They had few papers and four full days to discuss them in. There was no hurry. Plenty of time for even the most verbose and the attendance settled itself back to squeeze the last thing out of every topic. No one felt crowded out and after an all day's session of five hours or more on a subject, it was pretty well threshed out insofar as that assembly could thresh it. The method is commended to other of the minor associations. Either this must be done, or if a larger number of papers are to be put upon the program, then a definite time limit should be put upon the discussion of each report, and that the greatest amount of time should be made available for discussion the papers should be read in abstract or by title. At any rate the method of few papers and a long time worked successfully with the Traveling Engineers.

Government Red Tape.

We saw a letter the other day written by a department head in Washington to a man in the field. A letter of censure, because the man had presumed to do something out of the routine. It seems that a certain society interested in matters upon which the department was at work held a meeting and this government employe with a most unwarranted initiative had presumed to take an afternoon off and address the meeting, setting forth the work of the department, and showing the great amount of good that it was bestowing on all concerned. It was a good thing for the government to get this exposition, as it created a friendly feeling all around. And so the innocent of unspeakable initiative reported the matter to his chief, with the naivette of a child who expects commendation, but received, instead, a letter of censure and the cold bare statement that the time lost from government service by that afternoon's performance would be deducted from his annual vacation allowance.

It is a safe bet that that man will not step into that trap again, nor will any other of his pals who hear of it. What's the use? is a very natural motto for a government employe to adopt. He knows that his chance of reaching a position as a departmental chief is out of the question on the basis of merit. That Pull, Preference and Politics are the great agents of promotion, and why try anything else. Why not slam a stamp window shut in the face of a buyer on the second of closing time? The government will neither recognize nor appreciate the extra work. So why try? What's the use of doing more than hold down the job?

The Claims of the Railroad Professional Engineers.

It is gratifying to observe that considerable progress is being made as a result of the efforts by the American Association of Engineers to increase the remuneration of the mechanical engineers employed on railroads. It would seem as if this large and highly skilled class of men who may properly be said to hold responsible official positions have been overlooked in the desperate scramble for a larger share of the distribution of the products of their efforts. It is singular that the designing and constructing engineer should be outclassed by the mechanician. It is another proof of the axiom that the first shall be the last and the last first. A wise man said that we should let another blow our trumpet. This may have been the essence of wisdom three thousand years ago, when manly modesty was accounted a virtue, but we live in changed times, when the last to complain is generally the first to get left.

The mechanical engineers, however, have found a voice, and from a report issued recently by the railroad committee of the American Association of Engineers we have the entire story of the negotiations that have been carried on by the association relative to the increased salaries of railroad engineers, and which have been highly successful. The salary case of the railroad professional engineers was championed for the first time a year ago, when the association asked the Wage Board of the Administration for a hearing at which the claims of these engineers might be presented. This hearing was finally obtained last March, just after a conference had been held in Chicago by the association, at which several hundred engineers adopted schedules of salaries for various positions which were underpaid. The hearings resulted in favorable action by the Wage Board, and the point was almost reached when the Board was to issue a wage order placing new salaries into effect over the entire country. The movement for higher salaries looked like a complete success, but at this stage the Administration took the matter out of the hands of the Wage Board. The regional directors were instructed to make proper adjustment of salaries in their respective regions. It then became necessary to conduct independent negotiations with each regional director. This occupied the railroad department of the association for almost three months, until finally the tantalizing situation was relieved by the Northwestern Region issuing the first order and which increases the salaries approximately up to those which had been recommended by the American Association of Engineers.

Since then the Eastern Region has announced that the new rates for professional engineers are ready, and are being printed for distribution and may be looked

for during October. The other regions are expected to be heard from at an early date, and the result may be taken as another proof that a unity of action is the only path to pursue looking towards that element of justice and fair play which ought to come.

The Channel Tunnel.

Some things will not down and he is a fairly old man who can remember when the channel tunnel scheme was not either actively before the public or hibernating, awaiting favorable weather for reawakening and the resumption of normal activities. Some day it will come and that may be soon. A few days ago a simple notice appeared to the effect that a French commission appointed by the minister of public works had reported in favor of it and that the British government would probably appoint a Franco-British commission to conclude the necessary agreement between the two countries for the construction of the tunnel. From this it would appear that the reports that were circulated during the war that English public opinion had undergone a change regarding the channel tunnel has a foundation in fact. That the tunnel is needed and was sorely needed during the past four years goes without saying.

The scheme for a tunnel under the English Channel dates back to 1860 when a memorial was presented to parliament urging the desirability of building the tunnel. At that time, the scheme was to a great extent purely visionary because the tunneling facilities available would have been quite inadequate for such an enterprise. But the suggestion lived even though it might have been in embryo; in 1868 the idea came up again and a committee was formed to put it into execution. This committee had a life of four years and then in 1872, the Channel Tunnel Co. was incorporated. The object of this company was the construction of the tunnel. It kept its project before the country in a more or less intermittent manner for ten years. In the meantime papers on various features connected with the work were read before the technical societies of the country as well as appearing in the technical press. In 1876, for example, Mr. Morrison read a paper before the Institute of Civil Engineers in which he discussed the matter of ventilation very fully and showed how it could be accomplished. This was the one thing that seemed to stick in the crop of the public so far as the engineering features were concerned. Electric propulsion was a thing of the unthought-of future and to ventilate a tunnel twenty miles long that was to be traversed by steam locomotives was a task of no mean magnitude.

The years between 1878 and 1882 were years of some activity in the matter. A thorough geological survey of the chalk formations was made, and it was found that these formations extended from the English to the French coasts, that they were sufficiently near the channel bottom and of sufficient thickness to afford a constant material for tunneling purposes. With this information at hand the Channel Tunneling Co. started work. Their plans had been elaborated and were published in the scientific periodicals of the world.

The English end of the tunnel was to have been near Dover and a shaft was sunk to a depth of about 150 feet which was well below the channel bottom and then the heading was started. The plans called for a tunnel 13½ feet in diameter. This was driven forward for a short distance and then the inevitable happened. A banquet was held in this moist and subterraneous place in celebration of the actual start for France.

Unfortunately the promoters had not counted all of the elements that enter into the control of such a project, and one was public opinion.

It had the support, to be sure, of the railways and shippers and many engineers of prominence, but there was the old and conservative element of the English to be counted upon, to say nothing of the military party that really held the reins in the matter. Articles appeared in the *Times* condemning the scheme as visionary, written for the most part on a purely hypothetical basis, but still with an earnestness to convince the unthinking man of their soundness. Take this, as an example which is quoted from a two-page article which appeared in *Engineering* in 1876 by Baron von Weber.

"Thus, the execution of the channel tunnel threatens the English railway system, which has hitherto been quite freely developed in a manner most congenial to the English character and country, with an invasion of foreign vices and influences which may certainly bring home some advantage here or there, but which will possibly destroy the peculiar stamp of the English system and certainly cause many complications and great expense."

Thereupon he proceeded to show how English exports were greater than her imports and that therefore, there would be more English cars wandering over the uncharted roads of the continent than could possibly be of foreign cars on the English roads. Hence, in case of war, there would be a tremendous loss of rolling stock. So he concludes with the statement:

"The idea of the submarine tunnel is, therefore, one of those conceptions of which fancy with high sounding phrases about international traffic, conquest of the sea, etc., and the inviting pictures of the conveyance of enormous masses has played the principal part. In reality the project has arisen from the fear of sea-sickness, and is therefore, literally a sickly and diseased one unworthy of notice."

Such lucubrations coming from those high in some sort of circle had their effect, but the main damper was put on the scheme by the army.

So, when in 1882, the work had actually been started, the real bugaboo of the danger of foreign invasion was raised. If there is any one thing that the English have feared more than another, it is foreign invasion. They had had their taste of it at the time of the visit of William the Conqueror and the battle of Hastings, and what had happened once might happen again, and why court disaster?

So the army party headed by the Duke of Cambridge and Lord Wolseley painted such a picture of imminent danger to the country before the parliamentary committee that was considering the matter that work was stopped and nothing more done. Why Lord Wolseley, whose position was the result of a series of happy accidents, and the Duke of Cambridge, whose chief mental qualification was the accident of his birth, should have been able to pull the wool over the eyes of a nation, it is difficult to explain. But they did, and the whole country stood aghast at what might happen to them if a channel tunnel should be built. They were told that it would require the erection of a first-class fortress costing from $1,250,000 to $7,500,000 and manned by at least 10,000 troops to protect the Dover end of the tunnel, besides which there would have to be so many dangerous safeguards instituted that no one would be willing to travel that way. In short the tunnel would be a standing menace to the country as a whole and to those individuals who should be rash enough to attempt to travel through it. So the 1882 project came to an end.

We can well recollect how the scare of invasion shook England a few years ago after the presentation of a rather sensational play on the boards of a London theatre, and how they congratulated themselves at the time that there was no tunnel.

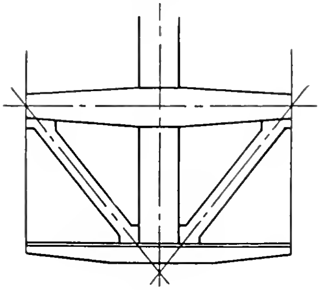
But experience is a useful guide to those who will follow it, and the experience of the past four years has apparently shown the English people that the tunnel will be a good thing and a fine insurance against a repetition of what nearly happened this time and there will probably be no hysterical opposition to the scheme from this time on. Of course, with the present facilities for tunnel work and with electricity available as a motive power, many of the physical difficulties that would have had to be overcome in 1882 have disappeared, and there is nothing from an engineering or operating standpoint that can cause any hesitation whatsoever.

Diagonal Frame Bracing of Freight Cars

There are two methods of placing diagonal braces in car framing between the end sill and the bolster. One is to run them from the junction of the end and center sills out to the end of the bolster and the other to run them from the corner of the car in to the junction of the center sills with the bolster. The two methods are shown in the line drawings, Figs. 1 and 2, respectively.

Each has its advocates or each

FIG. Nº 1.



450,000 LBS.

would not be represented in current car construction. A brief resume of the arguments in behalf of each may be stated as follows:

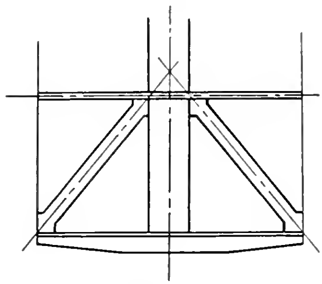
The use of diagonal braces from the center out to the end of the bolster (Fig. 1) relieves the end sill of all buffing stresses and carries a portion of these stresses out to the end of the bolster where they are absorbed and distributed by the bolster and the side sills and framing of the car.

Diagonal braces from the corner to the center (Fig. 2) stiffen the corners, prevent yielding and distortion under poling stresses, put a portion of the buffing stress on the end sill, and, finally, after putting a portion of the stress on the side sills carry the balance back to the stiff center sills.

From an examination of a number of cars that have been damaged by end blows it would seem that the method of placing the braces shown in Fig. 1 is much superior to that of Fig. 2.

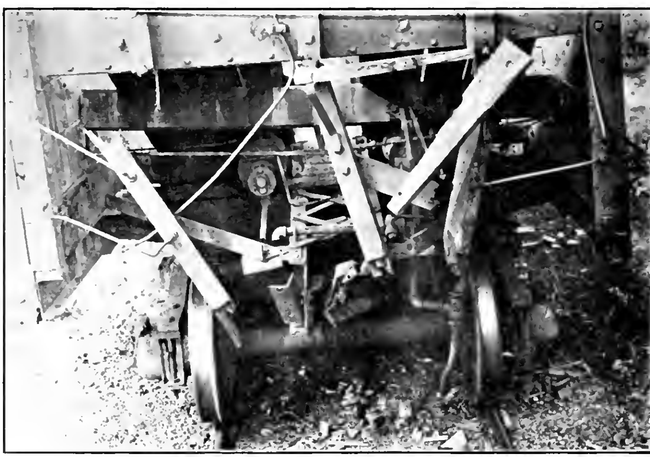
If an analysis of the distribution of the shocks to which a car is subjected be made, the first point to be considered is the point at which the shocks are applied. This is at the drawhead. Those shocks which are applied elsewhere are more or less incidental and accidental. The pulling stresses are insignificant when compared with the buffing and will rarely exceed, in all probability, 200,000 lbs., while the buffing stresses will often run to 450,000 lbs. or more. Now suppose the center sill to be of an approved steel construction with a sectional area of 24 sq. in. Its natural elasticity causes it to yield under every impact; the amount of which depends upon the intensity of the blow, its own rigidity and the solidity of the supporting base at the other end, which may range all the way from nothing with the car standing alone and free to move to immobility with its drawbar in contact with a buffing block.

FIG. Nº 2.



450,000 LBS.

With the diagonal braces located as in Fig. 1, any inward movement of the end of the center sills is communicated to the diagonal braces and by them, less their own resiliency, to the ends of the bolsters. No stress therefore is put upon the end sills or the side sills



END OF CAR BROKEN BY BLOW, CENTER SILL AND END DIAGONALS UNINJURED.

between the end sill and the bolster beyond that due to their own inertia as resisting motion.

Whatever stress is communicated to the diagonals is carried directly back to the ends of the bolster.

Suppose now that we consider the case of a car loaded with coal, wheat or any other bulk material.

It is well known that in grain elevators only a small portion of the weight of the grain in the bin is carried on the floor of the same. The wheat arches and by a heavy pressure against the walls of the bin produces so great a frictional resistance that the major portion of the weight is carried by these walls. That is to say, the tendency to a downward movement of the grain is resisted by the walls.

In the case of a car we have the identical conditions except that if the car is moved the motion is imparted to the load in a horizontal direction and if it is a box or hopper car the end becomes the bottom and the sides the walls against which the load arches and it must be moved through its friction against those sides rather than by a pressure exerted by the ends directly against the load. Hence it follows that, if the bracing of Fig. 1 be used, any motion of the center of the end sill is communicated directly to the sides and a pressure is applied at a point where the maximum resistance of the load to motion is concentrated.

There can be no doubt that a stress of considerable magnitude must be applied at that point in order to move the load. If this stress is carried thither direct from the drawbar by a stiff diagonal brace the distortion of the framing will be much less than it would be were it to be carried in the roundabout route from the drawbar through the end sill to the side sill, or back to the bolster and thence out to the end of

the latter, for it is evident that a diagonal brace running from the corner of the car in to the center cannot be instrumental in taking a stress from the drawbar to the end of the bolster. Therefore, the proper delivery of the necessary portion of the load at the the stress acting between the rear follower stops. It is because of the location of the impact point near the bolster that the diagonal braces of Fig. 2, being under tension, should transmit more of the impact stress than those of Fig. 1.

The one thing for which the brace of photographs of a car whose end was badly wrecked by a blow at the end. The condition of destruction of the end and end sill is very clearly shown by the photograph of the end. But even in this picture it will be seen that the center sills, side sills and diagonals are

UNINJURED DIAGONAL BRACE IN CAR WITH BROKEN END.

end of the bolster depends upon the resistance of the bolster and the end sill to bending, and certainly that cannot be as efficient as a stiff and straight strut running from the point of reception to that of delivery.

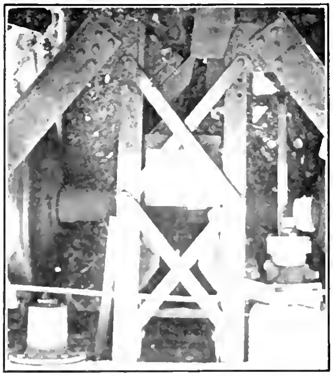
However, the point is not conceded by those who advocate the method of bracing shown in Fig. 2. It is claimed by them that the car sides can thus be made to help in buffing resistance, because the braces are thus in a position of tension to resist buffing stresses, while the arrangement of Fig. 1 puts them in compression. This claim is further made that, owing to the location of the wheels directly beneath the diagonals, as shown in Fig. 1, the depth of the braces cannot be more than 2 ins. or 2½ ins. This would make it of but little value as a compression member. As a matter of fact, however, there can be 5 ins. or 6 ins. clearance above the wheel flange. But, to continue, the advocates of Fig. 2 call attention to the fact that the buffing shock is delivered to the rear follower stops at a point near the bolster. It is, therefore, necessary to transfer this shock through the draft sills to the end sill and thence back through the diagonals to the car sides at the ends of the bolster. In this it is probable that so much flexibility would be developed that the center sills would really have to take 100 per cent of Fig. 2 is thought to be serviceable in the prevention of frame distortion due to stresses imposed upon the corner of the car. These may be caused by a side swiping blow or a poling of the car. As for side swiping, it is doubtful if any form of brace can prevent distortion or destruction under this form of treatment, while poling is a gentle push and is rarely or never delivered in the form of a blow. And yet, even here, the repair yard evidence is to the effect that it not only does not protect the corner from distortion due to a side swiping blow, but transmits the stress to the center sills and, by bending them, makes straightening necessary, while if the brace were not there, this item of repair work would be avoided. Hence while the brace of Fig. 2 may be theoretically desirable for the reasons given, as a matter of fact it is inefficient in one case and unnecessary in the other.

These are the arguments that may be raised *pro* and *con* for the two methods of bracing.

Now what does that comprehensive school of car construction, the repair yard, tell us?

The accompanying reproductions of photographs show the effects on end sills and bracing of heavy blows delivered against the drawbar and center line of the car.

Attention is first called to a series of straight. This is brought out more clearly in the three supplemental photographs of these details. They show each of these three pieces as straight as when they were new and freshly put in position, demonstrating that in this particular case, at least, they were



UNINJURED CENTER SILL OF CAR WITH END BROKEN BY BLOW.

efficient in holding the framing, of which they formed a part, in line.

Another photograph of an end sill was taken as a sample of a number of

cars in a repair yard that had been struck heavy blows on the drawbar. These cars had the diagonal braces running in from the corner to the junction of the center sill and bolster, and

BENT END SILL WITH DIAGONALS LIKE FIG. 2.

each had the end sill bent inward at the center as shown in the photograph. In short, the stiff diagonals had so braced the corners that end sill bent before they would yield and so the

BUCKLED CENTER SILL WITH ARCHED COVER PLATE.

center sill was obliged to sustain the full force of the blow, and any movement carried out to the side sills was at the expense of bending the end sill and putting a bending stress upon the bolster. This is a characteristic condition of damaged cars which are braced in this way. As far as any protection to the end sill is concerned, except for corner blows, the diagonals might as well not be there as to be arranged as shown in Fig. 2.

There is another matter of center sill construction that may be mentioned in this connection, and that is the use of an arched upper cover plate. This form is used for the double purpose of stiffening the center sills and of assisting in directing bulk material such as ore or coal to the chutes. The repair yard has many tales to tell of the inefficiency of this form of cover plate. It apparently fails to stiffen the center sills between the bolsters and, where the total sectional area of the center sill does not have a wide margin of strength, the arched cover plate seems to add little to the strength of the sills when considered as a column.

The accompanying photograph shows a common form of yielding that takes place with this form of cover plate. From the review of repair yard evidence it appears that the plain flat cover plate suitably riveted in place is a much better construction.

There is this to be said, however, that in the ordinary form of construction the rivets are spaced so far apart with the arched cover plate that it does not form the same integral part of the center sill that the flat plate does with the closely spaced rivets that are usually used with it.

These are matters of, it may be, minor detail in car construction and are presented for consideration purely from the standpoint of repair yard evidence.

INTERNATIONAL RAILWAY CONGRESS ASSOCIATION

M. L. Weissenbruch, the general secretary of the International Railway Congress Association at Brussels, Belgium, has issued a circular announcing that the association has been reorganized under the title of the International Railway Association. It will be remembered that this association held meetings at five-year intervals, no two having been held in the same country, except the third and sixth, which were held in Paris. The seventh meeting was held in Washington in 1905, that of 1910 was at Berne, Switzerland, and that of 1915 was to have been held in Berlin, but was omitted because of certain international difficulties then in process of adjustment. The growth of the association was rapid, having risen from 19 governments, 131 railways, 31,070 miles of track, and 289 delegates present in 1885, to 48 governments, 420 railways, 359,858 miles of track, and 799 delegates present at Berne in 1910.

After the return of the Belgian government, the association was placed under sequestration, in pursuance of the Belgian law of November 10, 1918, owing to the fact that a portion of its assets belonged to the subjects of enemy nations.

The sequestrator having ordered the dissolution and liquidation of the society, the railway administrations, members of the association, belonging to 35 countries in and outside Europe, decided to transfer their property to an association established upon exactly the same basis as before, and entitled the "International Railway Association." These countries are: Argentina, Belgium and colony, Bolivia, Brazil, Chili, China, Costa Rica, Cuba, Denmark, Dominican Republic, Ecuador, Egypt France, Algeria, Tunis and colonies, Greece, Haiti, Italy, Japan, Luxemburg, Mexico, Netherlands and colonies, Nicaragua, Norway, Paraguay, Peru, Portugal and colonies, Rumania, San Salvador, Serbia, Siam, Spain, Sweden, Switzerland, United States of America, and Uruguay.

The statutes of the original association, now dissolved, have not been altered. All that has been done has been to add to them an article, in the following terms:

"The Permanent Commission by the written vote of a three-quarters' majority of the votes of all its members, decides the countries included in the association."

As a first manifestation of the resumption of activity on the part of the association, the executive committee will recommence shortly the publication of its monthly Bulletin.

The permanent commission which will be convoked at an early date will be called upon, as a primary duty, to declare itself on the subject of the place and date of the ninth session, at which the statutes in their complete form will be discussed by the plenary assembly with a view to its approval.

Valuable words and signs of encouragement from all quarters have reached the executive committee, and the latter has every reason to hope that the "International Railway Association" will continue to pursue with more success than ever the aim which its predecessor assigned to itself: to further the progress of the science and working of railways.

Air Brake Department

Questions and Answers

Locomotive Air Brake Inspection.

(Continued from page 276, Sept., 1919.)

923. Q.—What should be noticed in connection with the vent port?

A.—That it is open and of the proper size.

924. Q.—What is the correct size of the port?

A.—1/32 inch.

925. Q.—What is the object of this port?

A.—To exhaust the pressure from the governor cylinder after the diaphragm valve was closed.

926. Q.—The result of a stopped up vent port?

A.—If the packing ring is a good fit, the pressure remaining bottled up above the governor piston will not permit the steam valve to open and promptly start the compressor.

927. Q.—Has the port any other use?

A.—Yes. It discharges enough main reservoir pressure while the governor is in control of the compressor to avoid the compressor being shut down for any considerable length of time that would permit an excessive amount of condensation in the steam cylinders.

928. Q.—Which vent port should be plugged with the excess pressure and maximum taps, known as the SF governor?

A.—The excess pressure top while the other should remain open in the maximum top.

929. Q.—Why so?

A.—This will avoid having maximum tops in stock with the vent ports closed, unless the SD type of governor is used, in which the vent ports of one of the tops must necessarily be plugged.

930. Q.—What is one of the advantages on the SG governor in this connection?

A.—There is but one vent port which avoids the confusion of sometimes having governor tops with both ports open or possibly with both ports plugged.

931. Q.—Is it possible to have the diaphragms of a governor too rigid?

A.—Yes, from tightening the spring box too tightly while there is no air pressure under the diaphragms.

932. Q.—How can this be corrected after the governor is applied to the engine?

A.—By slightly slacking off and retightening the spring box after there is a considerable pressure in the main reservoir.

933. Q.—What is the effect of having the diaphragms too rigid?

A.—The governor will not operate on slight variations in main reservoir pressure.

934. Q.—What other common disorder may prevent the governor from being sufficiently sensitive?

A.—Friction at the ends of the regulating spring.

935. Q.—How is it remedied?

A.—By using a drop of oil on each end of the spring.

936. Q.—What is the object of the leakage port in the spring box?

A.—To prevent any possible leakage past the diaphragms from accumulating in the spring box.

937. Q.—What would be the effect of leakage past the diaphragms that would build up a pressure in the spring box on account of this port being stopped up?

A.—The air pressure would equalize above and below the diaphragms, and the regulating spring would hold the diaphragm valve to its seat and the governor could not stop the compressor regardless of the pressure obtained in the main reservoir.

938. Q.—What is the object of the small drilled port through the steam valve of the governor?

A.—To permit a small amount of steam to pass to the steam cylinders regardless as to whether the governor has the compressor shut down for a considerable period of time.

939. Q.—When is this desirable?

A.—In cold weather.

940. Q.—What is wrong with a governor that occasionally permits boiler pressure to accumulate in the main reservoir, or that will not stop the compressor until after it is tapped with a hammer or wrench and thereafter operates correctly for some time?

A.—It is generally due to the regulating spring catching in the spring box and holding the diaphragm valve to its seat. The tapping loosens the spring.

941. Q.—Sometimes this disorder is noticed but once, that is, after the engine has had the fire drawn for some time. In pumping up the pressure when the compressor throttle is first opened, the governor fails to stop the compressor, and after tapping it it gives no further trouble?

A.—This is generally due to a gummy substance hardening around the diaphragm valve and seat. Tapping the governor loosens this matter or at least a portion of it, and thereafter the governor operates correctly.

942. Q.—What are the ordinary causes of a governor failing to stop the compressor when the desired air pressure has accumulated?

A.—The regulating nut screwed down too tight, stoppage in the governor pipe, excessive governor piston packing ring leakage, port under diaphragm valve closed with dirt and waste pipe stopped up.

943. Q.—How does the closed waste pipe prevent the operation of the governor?

A.—By allowing steam at boiler pressure to accumulate under the governor piston when the governor piston starts downward.

944. Q.—At what point does steam pass into the governor cylinder under the piston?

A.—Between the steam valve steam and the cylinder body.

945. Q.—What principal defects prevent the governor from permitting the compressor to start promptly upon a depletion in pressure?

A.—A closed vent port in the neck of the governor, a leaky diaphragm valve, buckled diaphragms, diaphragms or diaphragm valve too rigid, or packing ring leakage.

946. Q.—How is diaphragm valve leakage detected?

A.—By leakage from the vent port, after main reservoir pressure has reduced considerably below the maximum carried.

947. Q.—What is the object of the cut out cock in the reservoir pipe of the E T or L T brake equipment?

A.—To cut off the main reservoir pressure from the rest of the system, when it is desired to remove or repair any of the equipment in the cab or under the running board without bleeding all the air out of the main reservoir.

948. Q.—What should be done before closing the reservoir cock for the removal of any parts?

A.—The stop cock in the brake pipe under the automatic brake valve should be closed, and the automatic brake valve placed in release position.

949. Q.—For what purpose?

A.—To prevent the brake valve rotary from becoming unseated.

950. Q.—How would it become unseated?

A.—When the reservoir cock is closed reservoir pipe pressure escapes from the top of the rotary valve giving brake pipe pressure an opportunity to unseat it.

951. Q.—What causes the escape of reservoir pipe pressure?

A.—A vent port in the side of the cut

out cock that opens the reservoir pipe to the atmosphere when the cock handle is moved to the closed position.

952. Q.—How does placing the brake valve in release position prevent the unseating of the rotary valve?

A.—By making a direct opening from the brake pipe to the reservoir pipe.

953. Q.—How would the feed valve be affected through a failure to move the brake valve to release position before closing the reservoir cut out cock?

A.—The supply valve might be unseated through the reservoir pressure suddenly leaving the supply valve bushing.

954. Q.—What would likely result from these valves becoming unseated under the conditions mentioned?

A.—Dirt or foreign matter lodging on the valve seats might start them to leaking.

955. Q.—How is this matter handled when the brake valve cut out, or double heading cock is located in the reservoir pipe?

A.—The cock is not turned, but the brake valve handle is placed in release position before the main reservoir cut out cock is closed.

956. Q.—How many pipe connections has the brake valve cut out cock, when located in the reservoir pipe?

A.—Three. The reservoir pipe, reservoir gage pipe, and the brake valve service exhaust pipe.

957. Q.—What additional pipe did the previous types of cocks have?

A.—A pipe leading from the brake pipe to the large end of the cock, usually called balance pipe.

958. Q.—What was it used for?

A.—To assist the spring in the cock in holding the plug valve to its seat.

(*To be continued*)

Train Handling.

(*Continued from page 278, Sept., 1919.*)

975. Q.—Are broken air pipes with the LT equipment handled the same as with the ET equipment?

A.—Practically in the same manner but with a few slight exceptions.

976. Q.—What is one of them?

A.—With a broken control valve supply pipe, the locomotive and tender brake can still be applied with the straight air brake.

977. Q.—And while the train brakes are being applied with the automatic valve?

A.—The straight air can be used on the engine and tender.

978. Q.—How should the leak from the broken supply valve pipe be stopped?

A.—By closing the cut out cock at one end and plugging the other.

979. Q.—Why close both ends of the broken pipe?

A.—To prevent a waste of air if the brake is applied in emergency or with a heavy or over reduction in brake pipe pressure.

980. Q.—Where would this waste be from?

A.—Out of the brake pipe, through the quick action cylinder cap and through the broken supply pipe.

981. Q.—If a distributing valve supply pipe was then broken off would it not be of advantage to plug both ends of the broken pipe, that is, closing the stop cock in one end and plugging the other?

A.—Yes, it would provide a brake for the engine and tender for emergency applications of the brake, also one in case of an over reduction in brake pipe pressure.

982. Q.—In what manner?

A.—By a flow of air from the brake pipe through the quick action equalizing cylinder cap into the brake cylinders when the equalizing valve moves to emergency position.

983. Q.—Are brake valve equalizing reservoir pipe, gage pipes and governor pipes if broken with the LT handled same as with the ET?

A.—Yes.

984. Q.—And with a broken off brake pipe forward or back of the brake valve branch on passenger engines?

A.—Yes, they are handled in the same manner.

985. Q.—What if the brake pipe is broken off at the automatic brake valve, or if broken back of the brake valve branch on a freight engine?

A.—The straight air brake valve will be used to operate the train brakes.

986. Q.—How will the connection be made?

A.—Between the brake cylinder hose rear of engine and the brake pipe hose front of tender.

987. Q.—What would be the first thing to be done when the broken off pipe at the brake valve exhausted the brake pipe pressure and stopped the train?

A.—The automatic brake valve handle would be placed on lap position to hold the main reservoir pressure and the brake on the engine would be released with the straight air valve in automatic release position.

988. Q.—And thereafter?

A.—The stop cocks in the brake cylinder pipe leading to the driver brake, truck brake and other cylinders, except the one toward the tender cylinder would be closed.

989. Q.—And then?

A.—The hose couplings mentioned would be hammered together and the straight air brake valve placed in full application position, the safety valve adjusting nut screwed down and the pressure increased by screwing in on the adjusting nut of the reducing valve.

990. How should this be done?

A.—The pressure for the straight air pipe used as a brake pipe should be adjusted with the angle cock at the rear of the tender closed and the cock opened afterwards.

991. Q.—And what should be done while the brakes are releasing and the brake system is charging for a brake test?

A.—The stop cock in the control valve supply pipe should be closed, and the union connection on the automatic side of the double check valve should be slacked off in order to permit a leak if air accumulated in the pipe at the automatic side of the check valve.

992. Q.—The object of closing the supply pipe cock?

A.—To prevent the possibility of main reservoir pressure coming through the application portion of the control valve into the brake cylinder pipe.

993. Q.—And of slacking off the union connection?

A.—To keep this pipe free of air pressure.

994. Q.—What might be the result of pressure bottling up in the brake cylinder pipe?

A.—The double check valve would be shifted and cut the straight air brake valve off from the brake pipe.

995. Q.—How would the train brakes be applied, after these connections have been made?

A.—By moving the straight air brake valve to release position.

996. Q.—Exhausting pressure from where?

A.—The brake cylinder pipe of the engine and the brake pipe of the train.

997. Q.—And if the check valve should flip over from pressure built up in the brake cylinder side of the check valve?

A.—It would prevent the application of the brake.

998. Q.—And the normal position of the straight air valve while running along the road?

A.—Full application position, admitting the maximum amount of air from the main reservoir to the brake pipe.

999. Q.—What controls brake pipe pressure?

A.—The reucing valve.

1000. Q.—Can this same arrangement be used if both the reservoir pipe and feed valve pipe were to be broken off at the brake valve at the same time?

A.—Yes, after stopping the main reservoir leak.

1001. Q.—On a lone engine, why will the brake generally apply if the brake valve handle is moved to release position and left there for some little time?

A.—Because the exhaust port of the equalizing slide valve is closed and any

air pressure entering the application cylinder applies the brake.

1002. Q.—Where would the air pressure entering the application cylinder be from?

A.—Through leakage into the cylinder or from movements of the equalizing slide valve.

1003. Q.—How would a brake pipe reduction necessary to move the equalizing piston and slide valve occur with the valve handle in release position?

A.—Through the warning port of the brake valve and through the relief port in the neck of the governor.

1004. Q.—And the reduction is caused through?

A.—The same depletion of pressure in the brake system that is necessary to cause the governor diaphragm valve to seat and allow the governor to start the compressor.

1005. Q.—What would be indicated if the brake did not apply in a short time after the brake valve was placed in release position?

A.—That the governor was more sensitive to permit the compressor to start than the equalizing portion of the distributing valve was sensitive in movement.

1006. Q.—Ordinarily about what rate of brake pipe reduction is necessary to operate a distributing valve in good condition?

A.—About 15 lbs. drop per minute.

1007. Q.—What is the rate of brake pipe reduction necessary to produce quick action?

A.—About 20 lbs. in two and one-half seconds.

1008. Q.—Does this apply to an engine with the release pipe branch between the brake valve disconnected?

A.—No. Movements of the equalizing valve may occur but build up no pressure in the application cylinder, as the application cylinder will be opened to the atmosphere each time the equalizing valve moves to release position.

1009. Q.—What should be done, if when running along the road, the valve handle was placed in service and the brakes did not apply?

A.—The valve handle would be placed in emergency position, provided a brake application was necessary.

1010. Q.—Can the brake be applied in service with emergency position?

A.—Yes, as explained in connection with a broken equalizing reservoir pipe.

1011. Q.—What is generally wrong when this occurs?

A.—A small piece of pipe scale lodges in the preliminary exhaust port bushing.

1012. Q.—Otherwise?

A.—A bad leak has started between the brake pipe or main reservoir into the equalizing reservoir.

(To be continued.)

Car Brake Inspection.

(*Continued from page 278, Sept.,* 1919.)

897. Q.—Considering the complete LN equipment, what would be wrong if the safety valve of a triple valve started to pop after a 15 lb. brake pipe reduction?

A.—There would either be a leak in the brake pipe that continued the reduction, the safety valve would be out of adjustment, or the by-pass valve would be leaking.

898. Q.—How could the difference be distinguished?

A.—By knowing first that the brake pipe pressure remained stationary after a light reduction, then that the safety valve is properly adjusted.

899. Q.—What would then be wrong if the safety valve continued to pop after a light reduction?

A.—The by-pass valve would be leaking.

900. Q.—From where to where?

A.—Pressure from the supplementary reservoir into the auxiliary, thence into the brake cylinder increasing the pressure to the adjustment of the safety valve.

901. Q.—How will this defect usually be indicated when the car is in a train?

A.—After a light brake pipe reduction only the safety valve on the triple valve with the leaky by-pass valve will be popping.

902. Q.—How can an air gage be used to determine by-pass valve leakage?

A.—By attaching it to the supplementary reservoir, to note whether this pressure is falling while the brake is applied.

903. Q.—What is the effect of a leaky by-pass valve?

A.—Slid flat wheels and stuck brakes.

904. Q.—How does the triple valve fail to release as a result of by-pass leakage?

A.—It tends to increase auxiliary reservoir pressure at the same rate that brake pipe pressure is increasing, but before the triple valve piston is moved toward release position.

905. Q.—And how does it tend to produce slid flat wheels?

A.—By developing too high a brake cylinder pressure consistent with light brake applications.

906. Q.—How is the triple valve cut out when defective?

A.—By closing the stop cock in the brake pipe branch and bleeding both auxiliary and supplementary reservoir and leaving the drain cocks open.

907. Q.—How is the brake to be bled off when found to be sticking?

A.—With the auxiliary reservoir drain cock, closing it promptly as the brake starts to release.

908. Q.—What if the brake re-applies?

A.—Open the cock a second or third time if necessary.

909. Q.—What causes the brake to re-apply?

A.—It graduates from the inflow from the supplementary reservoir.

910. Q.—What is done if the yard plant carries a higher pressure than the locomotive that is to haul the train?

A.—The supplementary reservoirs are usually bled to a figure a trifle lower than the pressure carried on the engine.

911. Q.—With the brake applied, auxiliary and supplementary reservoir pressures separated, can the brake be released bly bleeding the supplementary reservoir?

A.—Yes, after the supplementary reservoir pressure is nearly exhausted, the by-pass valve will open the auxiliary to the supplementary.

912. Q.—Should the reservoirs ever be bled to release a brake when an engine is coupled to the train?

A.—No.

913. Q.—Why not?

A.—Because the engineer is in a position to know why the brake does not release, whether he has insufficient excess pressure or whether the reservoirs have been overcharged and should handle the brake accordingly.

914. Q.—What should be done if he cannot release a brake?

A.—If it is the only one that cannot be released from the engine, it should be cut out or repaired.

915. Q.—Why is it a bad practice to release a brake with a reservoir drain cock?

A.—It gives no assurance that the brake can be released from the engine, and bleeding wastes air that must be replaced from the locomotive.

916. Q.—About how many cubic feet of free air is contained in the reservoirs of modern cars of LN brake equipment, at 110 lbs. pressure?

A.—Anywhere from 80 to 200 cubic feet per car.

917. Q.—What is the storage space per car?

A.—From 10 to 20 or more cubic feet.

918. Q.—Assuming reservoirs of 15 cubic feet capacity per car, how many cubic feet of free air will be contained in a 10 car train charged to 110 lbs. pressure?

A.—$15 \times 8.5 = 127.5 \times 10 = 1275$ cubic feet of free air.

919. Q.—And the storage space is equal to that of about how many 8 in. freight car equipments?

A.—About 100 cars.

920. Q.—And the number of cubic feet of free air contained, 110 lbs. pressure on the 10 passenger cars and 70 in the freight cars?

A.—The number of cubic feet of free air stored in the passenger train is equal to that stored in about 170 freight cars of 8 in. equipment.

921. Q.—About how long would it take an 11 in. pump to charge a train of 10 of such cars of LN equipment to 110 lbs. pressure?

A.—About 30 minutes.

922. Q.—Or a cross compound compressor?

A.—Very nearly 15 minutes.

923. Q.—What does this indicate in connection with the "bleeding off" of the brake?

A.—That more compressed air can be wasted from the supplementary reservoir drain cocks in ten seconds time than can be replaced by the compressor in ten minutes time.

924. Q.—What could be wrong with a triple valve if the safety valve was found to be "popping" while the brake is released with no air pressure in the brake cylinder?

A.—It would be due to a very gummy condition of the graduating valve on its seat, and after a light brake pipe reduction a release has caused the slide valve to be moved with the graduating valve left open.

925. Q.—Or in other words?

A.—The graduating valve offers more resistance to movement than the main slide valve, or the momentary small difference between brake pipe and auxiliary reservoir pressure.

926. Q.—If it is desired to release the brake after an engine is cut off from the car, how should it be done?

A.—By bleeding the air pressure out of both reservoirs.

927. Q.—What sizes of triple valves are used with the different sized brake cylinders?

A.—The L-1-B with 8 and 10 inch cylinders, the L-2-A with 12 and 14 inch, and the L-3 with 16 and 18 inch cylinders.

928. Q.—Has the same thing that has been said concerning cleaning and lubricating triple valves any application to type L valves?

A.—Yes, the only difference is that with the L triple valves, additional tests are made for the quick service, graduated release, by-pass and safety valve features.

929. Q.—When a triple valve is being tested on a car, how much of a brake pipe reduction should cause it to apply?

A.—From 4 to 5 lbs.

930. Q.—How much of an increase in brake pipe pressure should cause an L triple valve to move to release position?

A.—From 2 to 3 lbs., made at a slow rate of increase, and if as much as 4 lbs. differential is required the valve should be removed or should receive attention.

931. Q.—When making the release test with a slow rise in pressure, the triple valve usually reapplies, why is this?

A.—From the supplementary reservoir pressure flowing into the auxiliary when the valve moves to release position, graduating the brake cylinder pressure.

(To be continued)

Critical Comments and Snap Shots

By the Wanderer

A story is told of the late George Westinghouse that once, while lunching with the officers of his several companies, he leaned back in his chair and said: "I tell you what, gentlemen, I have lots of fun doing business." I often think of the story as I talk to railway officers and hear the tales of their experiences under present conditions and wonder if there is one in this whole broad land that has any fun, to say nothing of lots of it, in doing business.

Red tape and suppression of initiative seems to be the order of the day and few there be who escape therefrom. I heard a tale the other day that is quite characteristic. There was a death in the family of a wealthy man and the interment was to take place about 60 miles from the place of decease. The man went to the general manager of the railroad and asked for a private coach to be placed on a certain train to carry the family so that they might be free from intrusion. Under ordinary circumstances the general manager would have ordered the car put upon the train, the family would have occupied it, the man would have paid the bill, the railroad would have made a profit and that would have been the end of it. But now? Oh, no! The general manager was not authorized to general manage outside the routine of service; so he referred it to one above, and the one above asked the regional director, and the regional director, or his chief clerk did not quite understand the situation, and after the exchange of five telegrams in each direction, with an eye on the possible disapproval in Washington, it was considered safer to refuse the request. But, there being no real reason for the refusal, the long distance telephone was put into requisition and then after more delay the request was granted.

Now let's estimate a little. Suppose the general manager to have been getting $12,000, and the man above and regional director not more than $15,000.

Under the old regime the general manager would have settled the whole business in five minutes at a time cost of approximately 40 cents. As it was we cannot estimate on less than an hour's service for each of the three high officials involved, costing about $18 for the three as against 40 cents for the old regime, or an increase of 45 times. Small wonder there is a deficit in railroad finance if this is a sample of present day efficiency. Note that no increase in cost because of clerical inefficiency is noted. And yet, government ownership is advocated.

A few weeks ago a railroad journal commented on the fact that a certain man who had risen high in railway officialdom had seen fit to suddenly resign and betake himself to a private enterprise. It made no surmise as to the reason for this, but remarked upon it as a matter of passing strangeness that such an one, with a brilliant career before him that had been earned by hard labor, should cast it aside with such seeming carelessness as though his past life and efforts had been of no moment to him at all. I wonder, and still the wonder grows, whether red tape and suppression may not have been factors and controlling factors in that resignation. Men of initiative who have been in the habit of acting on it and getting results, rather chafe at being relegated to an office boy's position, especially when their ultimate superiors apparently know so little about the business.

And now that we are wondering, let us wonder a little more and try to imagine what would happen to a Tom Scott or Andrew Carnegie who should presume to cut up such didos, under present conditions, as those youngsters executed in earlier days on the Pennsylvania. The story goes that when Scott was a station agent up in the mountains a wreck occurred nearby. Scott telegraphed the details to headquarters and as he listened to orders going to and fro on the wires for the clearing of the tracks he heard estimates of twenty-four hours to do the work with corresponding wailing at the unconscionable delay. So he decided to take matters into his own hands, and an hour later telegraphed that the track was clear.

And so Andrew Carnegie, a telegrapher under Scott, assumed the responsibility of issuing orders on his own responsibility in the case of a wreck and pulled it through. Of course, Scott, with recollections of the burned wreck and a few other personal performances, could hardly censure the young telegrapher. I believe Carnegie, in after life, became somewhat prominent in the iron industry.

So the old regime did not tend to completely break a man's initiative.

Electrical Department

Electric Locomotive Operation—The Care and Repair of Commutators

During the past few years the steam locomotive has been modified and changed so that the design has advanced and has been perfected, due to the introduction of economizers, superheaters, etc. The electric locomotive has more than kept pace with the rapid advance of the steam locomotive, however, and today we have single electric locomotives designed with axle loads of 65,000 lbs. and with continuous capacity ratings of 4,000 and more horsepower.

Let us get a general perspective view of the application of the electric locomotive to railroad work, and what advantages are gained by its use.

Electrification of steam railroads was progressing slowly before the war so that there were something like 3,000 miles operating electrically. But materials have greatly increased in cost, and it has been difficult to obtain labor except for military purposes, so that nearly all new construction work has stopped. Nevertheless, the war conditions resulting in heavy traffic congestion, and the very severe winters we have experienced, combined to show clearly the great advantages of electrification. During the severest winter, when the steam traffic was paralyzed the electric lines showed practically no disturbance.

The electric locomotive was first applied to terminal service. It was not a question of economies but a question of eliminating the steam power causing nuisance and discomfort to the passengers. While at first the benefits were not appreciated, it was not long before the many advantages of electric operation were realized, and now there is no other consideration for terminal operation.

Tunnels usually form the throat of railroad systems. Delays are necessarily incurred while waiting for the smoke to clear so that the signals can be clearly seen. Obviously there are very disagreeable features as regards passenger traffic, in addition to the danger of operation and delays. These difficulties have long been recognized by the steam railroad officials. Take, for instance, the Hoosic Tunnel of the Boston & Maine, built in 1875. The traffic of this road was greatly handicapped until its electrification. The tunnel was the "limited section of the division." Under steam operation the entire tunnel was a block five miles long, and no train was permitted to enter while a passenger train was passing through. With the change to electric service, the maintenance costs were greatly reduced. The old troubles have all disappeared, such as brickwork being shattered by engine exhaust, telephone and signal lines being corroded by acid gases, and bad failures caused by condensing steam. Formerly track gangs could only do approximately two hours of effective work out of a day's shift, whereas now the work can be carried out with safety and despatch.

The officials of the Grand Trunk Railway were among the first to realize the advantages of electrification for tunnel operation. They inaugurated electric service on the tunnel in 1908. The grades, approaches and inclines are 2 per cent, so that high tractive effort is required to operate the freight trains. Special anthracite coal burning locomotives were required prior to electrification, to reduce the smoke to a minimum. The maximum tractive effort of the steam locomotives limited the weight to about 760 tons and the speed up the grades was very slow.

Electrification not only eliminated the smoke and gases but increased the capacity of the tunnel about 100 per cent.

Freight haulage over heavy mountain grades has recently been added to the duty of the electric locomotive. The railroads derive practically 70 per cent of the total revenue from the transportation of freight and economies gained in this service have a large bearing on the total net revenue.

Greater operating economies have been obtained by the use of electric switch locomotives than in any other class of service. Only one half the number of electric locomotives are required, and the saving coal as determined by actual test runs is 66 per cent of the amount used by the steam engines. Standby losses are eliminated; full capacity power is available in freezing weather, and moreover, the electric switcher is available for service at all times.

The electric locomotive has demonstrated two things conclusively, namely: first, complete reliability under all conditions of service, and second, its low maintenance cost as compared with the steam locomotive. Approximately one-half of the costs of repairs of the steam locomotive is expended on the boilers, so that the maintenance of electric locomotives will average about 65% of the steam locomotive of equal weight.

In general the electric locomotive has characteristics which are especially advantageous to railroad operation namely:

1. Increase in track capacity in certain instances by 100%. Increased schedule speed results as stops for coal and water are eliminated.

2. Two or more units can be coupled together and operated by a single crew so that the locomotive has flexibility.

3. The electric locomotive can be operated equally well in either direction on account of the symmetrical wheel arrangement.

4. The steam locomotive spends only 30% to 40% of the total hours on the road. The electric locomotive is available for service over 90% of each 24 hours on account of no boiler or grate to clean; no water to take or no fire to light or bank. Moreover, greater mileages can be made between "stoppings."

5. The operation of the electric locomotive is very simple. All of the electrical apparatus is so arranged that by the movement of small handles the power is connected to the motors and the locomotive is brought up to speed.

6. It has the ability to maintain a rated speed and tonnage capacity irrespective of cold weather. The excessive radiation of heat is not disastrous as with the steam locomotive but it is of benefit, as more power can be passed through the motors without over-heating, resulting in an increase of horsepower.

7. The electric locomotive is operated from the head end where the engineer's vision is unobstructed and the best possible view of the track is obtained.

Electrical machinery can be designed more exactly to meet given conditions than any other class. Look at the reliability and freedom from failure of the electrified service in and about the city of New York. The two greatest railroad systems of the world have electrified terminals here, and the train service on both is far less subject to interruptions and delays since operated by electricity than under the best results ever obtained by steam.

There is no longer a question of whether electricity can do the work of broadening, extending and improving the very admirable performance of the modern steam locomotive. This has been amply demonstrated.

The trend is towards electrification not alone due to the many inherent advantages of the electric locomotives, but to other important reasons.

Electrification will increase the capacity of existing tracks and terminals—it will decrease the consumption of fuel—it will conserve labor.

Railroads must not become congested—they must always have a certain margin in which to expand and grow. Congestion generally is only at some particular section such as a tunnel or grade and the remedy must be applied at this point. Of course, the congestion can be relieved by adding more tracks; the grade could be cut down and curves straightened or a new right-of-way constructed, or heavier trains could be handled. It is very obvious that to carry out the first three methods would be very expensive and it is generally found that the maximum size of steam engines are already being used. Electrification is the answer. Take for instance the Norfolk & Western Railway. Congestion had been reached at the Elkhorn grade and tunnel. Three of the heaviest Mallets could only push and haul one of the coal trains over this section at 7 miles an hour. Electric locomotives were purchased and now the same weight trains are hauled over the same section at 14 miles an hour, doubling the capacity of the entire system.

As another example the P. R. R. terminal at Philadelphia was electrified. This station, one of the very busiest, had become very congested on account of train movements. No tracks could be added but the present tracks could be electrified—which was done.

Fuel is saved by electrification and where water power is available, as in the west, the economies are great. Our railroads are consuming 150 million tons of coal every year—nearly one-quarter of the entire production. The Chicago, Milwaukee & St. Paul Railway, operating 440 miles of road, saves 500,000 tons of coal and 250,000 barrels of fuel oil a maintenance. Labor is an important facyear.

The electric locomotive can haul larger trains at higher speeds so that a given number of men can handle a larger volume of traffic. Less labor is required for tor and anything that conserves man power increases national prosperity

Care and Repair of Commutators.

There are many electric machines having commutators and it is very necessary that same received proper care. Following is a brief description as to the care and repair of commutators. In order that the remarks will be understood two cuts are used, which show the construction.

The band over the front V-ring of a commutator should be wiped off every month. After cleaning, painting with an air drying varnish makes cleaning easier next time. Painting every six months is advisable.

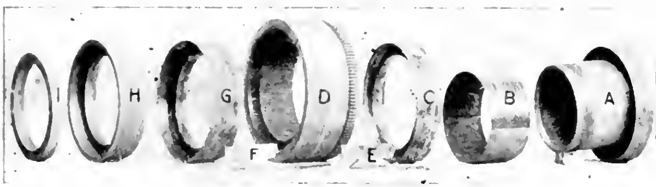


FIG. 1—DETAILS OF COMMUTATOR PARTS.

A—Metal bushing; B—insulating bushing or sleeve; C—rear mica V-ring; D—assembled copper and mica segments; E—mica strip or segment; F—copper segment or bar; G—front mica V-ring; H—metal V-ring; I—ring nut.

Flat spots, high or low bars, ridges, burned spots, etc., should be smoothed up. Where these are not bad, the motor need not be removed from the car. A tool can be made by mounting a block of wood on a stick, one face of the block being cut to the radius of the commutator and lined with sand paper or stone. As the car is run by the other motors, this tool, held against the commutator, will smooth the rough spots.

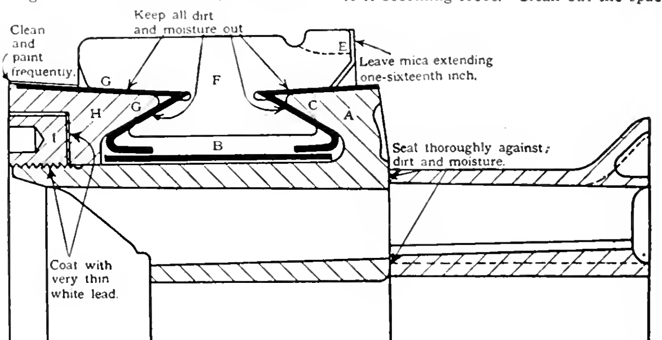


FIG. 2—SECTIONAL VIEW OF COMMUTATOR.

The armature should be removed from the car and placed in a lathe for turning the commutator, if its face is very rough. Holes left by defective mica or pits in the side of bars can be filled with commutator cement supplied by dealers.

The commutator should be re-undercut before it is worn flush, since the groove left will guide the saw and make the work much easier.

Where commutation trouble is frequent, it is good practice to use a V-shaped hand tool to round the edges of the under-cut grooves between bars to about 1/32-inch radius. This can be done with the motors in the car. All particles of mica, copper, or dirt should be removed from the grooves after undercutting.

A thin drift, driven in the top of the slot in the neck toward the shaft between the side of the commutator neck and the top filling piece, will loosen the filling piece so that it may be forced out by a gouge. Similarly, windings may be taken out of the first bar. With one set of leads removed there is enough space left to bend one side of the next neck, thus permitting the removal of the leads by means of the gouge. This can be done without heating the soldered joints.

Where a small number of bars are to be replaced it is not necessary to remove all the leads from the armature neck or take the commutator from the shaft. Stand the armature on end, commutator up. Mark each separate piece so that it may be put back in its old position. After removing the ring nut or bolts, take out the metal V-ring and mica V-ring. If the bars are tight, tapping with a wooden or rawhide mallet will loosen them. The new bar must be filed to the shape and thickness of the one which it replaces to prevent the new bar or the old bars next to it becoming loose. Clean out the space where new bars fit and tap them in with a soft mallet.

Detached parts of the commutator must be kept clean and dry. When the parts are ready for rebuilding, sand paper the mica V-ring. Clean the metal V-ring and the V in the commutator bars, and paint the V in the bars with shellac. The shellac and brush must be absolutely free from all dirt or moisture. After putting the mica V-ring and the metal V-ring back in their original positions, the ring nut or bolts are drawn up fairly tight.

Painting the threads of the ring nut or bolts with very thin white lead will make it easier to remove these parts next time. The commutator should now be heated to 110 degrees C. in an oven where the air is dry and the ring nut or the bolts drawn up tight while the commutator is hot. The commutator should then be turned in a lathe.

Test after these repairs should be 110 volts alternating current between commutator bars and 1000 volts alternating current to ground.

When it is necessary to replace the rear mica V-ring, a number of segments, or a complete set of segments, it is advisable to remove the commutator from the shaft. The method of taking down and rebuilding is the same as before described, being careful to heat the commutator thoroughly to soften up the new mica parts, so the ring or bolts can be drawn up tight. To this end when the commutator is assembled it should be put in an oven and heated to a temperature of 125 to 140 degrees C. While at this temperature the commutator is placed in a press, using a pressure of 20 to 25 tons for a 50 h.p. motor, and the ring nut is drawn up tight while under pressure.

Complete sets of segments are shipped, temporarily banded together, with the mica and copper segments in their proper position. The complete set should be assembled in the commutator as a unit and the temporary band should be removed just before the commutator is finally tightened.

Test after these repairs should be 300 volts alternating current between commutator bars and 2000 volts alternating current to ground.

Annual Convention of the American Railway Tool Foremen's Association.

The ninth annual convention of the above association was held at Chicago, Ill., in the last week in August. President C. A. Shafer occupied the chair and briefly reviewed the work that had been done by the association during the preceding two years in which no convention had been held, but two annual volumes had been issued showing that the committees had been active. An address of welcome was made by Grover Niemeyer, assistant state's attorney of Cook County. W. E. Dunham, assistant to the general superintendent of motive power of the Chicago & Northwestern, also addressed the convention, and dwelt strongly on the importance of the tool maker's work in maintaining efficiency on the entire mechanical departments of the railroads.

R. D. Fletcher, secretary and treasurer, reported that 29 new members had been added to the roll, and a cash balance of $348.70 was in the treasury.

E. J. McKernan presented a report on the subject of "Standard Devices Used on the Santa Fe." The paper was particularly interesting in view of the fact that it showed that many clever devices are being made of scrap material. A. M. Roberts reported on "The Standardization of Reamers for Locomotive Frame Work," and urged a closer coöperation between tool foremen and blacksmith foremen. G. W. Smith, of the Chesapeake & Ohio, presented papers on "Progress of the Association," and "Reclaiming Hancock Injectors." The former showed a continued gratifying growth of the work of the association, and the latter contained useful hints on the reclaiming of threads in pipe lines. J. C. Bevelle, of the El Paso & Northwestern, reported ably on "Jigs and Special Devices." J. J. Sheehan presented papers on "Device for Drilling Holes and Facing Front Flue Sheet for Steam Pipe Joint," and "Making Grease Cellars." J. H. Fuhrman reported on "Steel Forgings," and a second paper on "Valve Seat Reamers." W. H. Eiseman, of the American Steel Treaters' Society, delivered an interesting address on the "History of Steel Treating." Henry Otto presented papers on "Heat Treating in a Railway Shop," and "Women in Railway Shops." J. B. Hasty reported on "Shop Kinks," and in the course of the discussion that followed it was generally admitted that high speed tool steel is not sufficiently flexible for use in making staybolt taps.

The subject of "Women in Railway Shops" will be brought up for discussion at the next convention in 1920. Other topics selected and special committees to report thereon at the next convention include: "New Jigs and Devices for Locomotives and Car Shops," J. J. Sheehan, chairman; C. L. Watson, J. J. Sumner, Thomas Bell, J. P. Otten. "Standardization Taper Threads and Squares on Taps for Washout Plugs," E. J. McKernan, chairman; W. Perkins, J. D. Barnes, W. Wood, J. N. Meek. "Heat Treatment of Steel," C. A. Shafer, chairman; Henry Otto, W. J. Hynes, F. C. Courson, P. Renfrew. "Power Pinches and Dies," Charles Helm, chairman; J. E. Foley, S. F. White, H. Case. "Checking Out Tools," J. B. Hasty, chairman; C. E. Fisher, H. E. Muir, George Tothill.

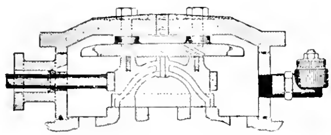
The following were elected officers: President, J. C. Reville, El Paso & Northwestern, El Paso, Tex.; vice-presidents, J. B. Hasty, Santa Fe, San Bernardino, Cal.; George W. Smith, Chesapeake & Ohio, Huntington, W. Va., and Charles Helm, Chicago, Milwaukee & St. Paul, Milwaukee, Wis.; secretary and treasurer, R. D. Fletcher, 1145 Marquette Road, Chicago, Ill. Executive committee—B. Hendrickson, chairman; A. Sterner, W. J. Hynes, J. B. McFarland, and C. C. Cuyper.

On motion, Chicago was again chosen as the meeting place of the next convention.

The Allen Slide Valve.

Among the multiplex changes and improvements in slide valves it is not surprising that some of them are not as prominently commented on as they might be. Among these the Allen slide valve is not now much heard of. As shown in the accompanying illustration its main feature is in the fact that it is a patent valve, which has the supplementary port above the exhaust arch, and was designed to overcome the defects of the plain slide valve. With the plain slide valve it was claimed by some authorities that it was impossible to secure a full boiler or steam chest pressure. Hence the Allen valve was designed to give a larger steam admission, and for a part of the valve travel the area of steam opening to the cylinder is actually doubled.

The valve is practically of no advantage in starting. It is at high speeds when the engine is worked at a short cut-off that the chief advantage is claimed from the Allen valve. This is due to the more rapid admission of steam into the cylinder, thus enabling the engine to develop more



THE ALLEN SLIDE VALVE.

power. There is one feature in the use of the Allen valve that is undesirable, and that is the fact that when the engine is running at short cut-offs there is about double the port area for admission of steam than that of exhaust, because the auxiliary port is used only for admission. There has always been considerable doubt as to the value of the Allen valve, but in many cases where it has not been approved of, the proper adjustment and method of applying has been more or less at fault.

In order to secure the best results from the use of the Allen valve its ports and bridges should exceed the full travel of the valve by at least ⅛ inch. Furthermore, the full advantage of the valve is not obtained if it is given as much lead as a plain slide valve. With a very long port an engine must be given less than with a short port, and with the Allen port the lead must be still further reduced—about half that of the plain slide valves. The Allen valve should also be given enough exhaust clearance to give a proper exhaust period, due to the fact, as already stated—that at short cut-offs there is double the port area for admission than there is for the exhaust, and without sufficient exhaust clearance the compression is apt to be excessive.

Systems of Electric Welding

By J. F. Springer

The use of the electric current in the generation of the heat necessary for a union of metallic parts has now been developed to a point where there are several successful systems. Localization of heat is the thing sought for and attained. That is to say, any systems of welding must be able to develop a high heat in a restricted space. Such heat may or may not be used to melt new metal and add it to the work. Arc welding is an example of the former spot welding, of the latter.

ARC WELDING.

In the ordinary electric arc light, the arc itself is formed by the passage of the electric current across the gap between electrodes. This gap contains, presumably, nothing but air and carbon. It is really a part of the circuit. The heat comes from the resistance to the passage of the current. The arc, once produced, is maintained, and the light produced is due, no doubt, to the incandescence of minute particles of carbon. In certain electric furnaces, one or more arcs are produced in and on the work. Great heat is produced as the current flows from one electrode to the work, from one piece of work to another, and from the work to another electrode. Whatever the gap contain, they are extraordinarily poor conductors of electricity, and so set up strong resistance to the passage of the current. The heat is consumed in melting the metal. With arc welding, the surrounding conditions essential to the procedure are much the same as in these examples of the use of the arc.

The work becomes, in effect, one of the electrodes. The other in the shape of a long rod, is held so that between the work and it there will be an arc. Naturally, one prepares the edges of the work so as to utilize the heat thus localized. That is, for example, one bevels the two edges and places them together in such a way as to provide a V-shaped groove. The arc is first formed, say, at the bottom of this groove. The object in view now is to use the heat in fusing the side faces of the groove and metal from the electrode. This is to be done in such a way as to fill the groove with metal from the electrode but at the same time have this new material more or less mingled with molten metal from the work. This mingling will naturally take place mostly on the faces of the groove. The object in mingling is to produce an actual union between old and new metal.

The current used in electric welding may be either direct or alternating. In general, the direct current is preferred. When alternating current is conveniently available, it may often be used as it is, but with the voltage reduced. Or, the conditions may be such as to make it, on the whole, advisable to transform the current into direct.

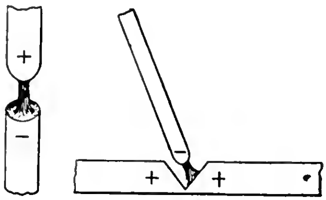


FIG. 1—THE ELECTRIC ARC BETWEEN TWO CARBONS. FIG. 2—ELECTRIC ARC BETWEEN CARBON AND THE WORK. ARC FLOWS FROM WORK TO CARBON.

When such transformation is to be effected, it will perhaps seem best to use a motor generating set. Naturally, transformation means loss; so that one would not elect to transform, unless there is some pretty powerful reason to do so.

The voltage used, if the current is direct, may run from 12 to 15 volts; if the current is alternating, from 20 to 30.

SPOT WELDING.

In spot welding, no additional material is employed. A customary application of this method is to the welding of metal plates. There is no trouble at all in welding plates up to ¼ inch thick. There is experimental reason to believe, however, that plates as thick as 1 inch may be successfully welded under this system.

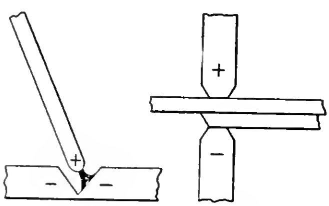


FIG. 3—ELECTRIC ARC METAL ELECTRODE AND METAL WORK. ARC FLOWS FROM METAL TO WORK. FIG. 4—WORK UNDER PRESSURE BETWEEN TWO METAL ELECTRODES. SPOT WELDING.

Spot welding is not unlike the kind of welding done by the blacksmith on his anvil. He heats the surfaces to be welded to a pretty high heat, say 1,900 or 2,000 degs. Fahr., and then forces them together by the use of a hammer or sledge. In electric spot welding, the electric current is employed to heat to a high temperature two ovelapping plates at a given spot where the plates are already under a heavy pressure that is tending to force them together. In a way, the blacksmith's procedure is reversed. The pressure,—which is the thing analogous to the force exerted by the sledge,—is operative before the heating is consummated.

More particularly, the two plates are pressed together by hydraulic or air pressure or some equivalent. An electrode on the upper side in full contact with a restricted area,—a spot,—corresponds to another electrode underneath which also corresponds to a spot of contact. Naturally, the current, when passed through the plates from one electrode to the other will follow the direct and shortest path. Alternating current is here used. Affairs are so managed that the current will meet high resistance in following this, the best available path, and this resistance heats the metal in that path. The combined effect of the pressure and the heat, this combination being realized between the spots of electrode contact, is to unite the surfaces at a region or spot lying between the electrodes.

The spot welding system is in particular competition with riveting. It is, perhaps, slower in operation than riveting alone. But, riveting generally requires one or two preliminary operations. With the spot welding systems, it will at times be possible to eliminate most if not all work of a preparatory character.

WELDING WITH COVERED ELECTRODES.

In the use of arc welding with ordinary metal rod or with a carbon electrode, trouble is sometimes experienced from the oxidation of metal in the weld. The heats are high and the atmosphere with its 20 per cent. content of free oxygen is always at hand. The combined effect, whenever it is realized, is oxidation of the metal. The presence of oxidized particles in the mass of the weld undoubtedly reduce its strength both in tension and in compression. The covered electrode is claimed to be a corrective of oxidation difficulties.

The covered electrode, in a representative case, consists in part of a metallic rod constituting the true electrode but forming only a core of the actual whole. Blue asbestos yarn is wrapped round to form a fusible covering. This yarn is understood to be a ferrous silicate. The fusing temperature is more or less controlled by using coating material on the yarn of the proper character. Sodium silicate or aluminum silicate is a suitable material. The asbestos yarn may have wrapped with it a fine aluminum wire.

When in use, the covered electrode is first applied to the work while the former is held vertical. An arc is formed. The electrode is then made to take an inclined position, but while this movement is going on the contact with the work is continually maintained. An inclination will be reached where the arc will cease to exist. But the current will still flow. The covering of the core is understood to be a non-conductor while solid, but a fair conductor when molten. A slag forms in the weld and presumably floats on it. The aluminum present in the form of a thin wire will readily melt, its temperature of fusion being about red heat; and as this metal has a great affinity for oxygen, it will tend to combine with any oxygen in the neighborhood. Likewise, the ferrous silicate acts as a deoxidizer when fusing.

Either alternating or direct current may be used. The voltage required may be 100 or 110 volts. A single operator may handle an electrode carrying a current having an amperage up to about 200. A covered electrode is also used in the alternating-current, short-arc system.

THE ORIGINAL SYSTEM.

Electric welding appears originally to have come into existence in a form differing from that of the arc process. At any rate, the system as described by the company which bears the name of the original inventor resembles more the procedure now known as spot welding, seeming indeed to include a form of spot welding as part of itself.

The metal parts to be united are put into contact in the proper position and a heavy current at low voltage is passed through. At the region of contact, the current meets with high resistance, and in consequence generates heat. The heat is concentrated, however, to the immediate vicinity of the contact and is highest at the surfaces of contact. When these have reached a welding temperature, pressure is applied so as to force the surfaces together, whereupon the current is turned off. The result is a blacksmith's weld, accomplished by steady pressure instead of by the sudden blows of a sledge.

REMARKS ON THE TWO VARIETIES OF ARC WELDING.

Arc welding may be divided into two procedures, according as one uses a carbon hand electrode or a metallic hand electrode. In the former case, the carbon has no especially important function other than to convey the current and assist in providing the arc. But, where the metal hand electrode is used, this electrode not only conducts the current and assists in maintaining the arc, but it supplies the new material which goes into the weld. Where the carbon electrode is employed, a separate rod supplies the new material.

The wasting away of the end of the metal electrode is accomplished, it seems, particle by particle. Further, it appears that these are *driven* against the work. This peculiarity is of advantage, at times, especially when it is desired to deposit new metal on vertical and overhead surfaces.

When a carbon electrode is used, the carbon is operated much after the manner of a soldering iron, although it is perhaps best to say that the new material is melted principally in the arc and not so much by the contact of the carbon.

A Check Board

By A. C. CLARK, Pittsburgh, Pa.

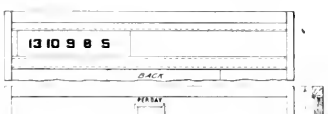
The time clock so extensively used for checking men into and out from work is an expensive article and there are some places where the proprietors or managers do not feel that they can afford one. For such places a very good home-made substitute is offered here.

The one shown consists of a board 38½ in. square and fitted with grooves for carrying slides somewhat after the form of the old fashioned sentence slides used for the blind. The blocks used are 2⅝ in. long and carry a man's name and number printed on the front and back.

On coming to work the employes find their blocks under the outside of the column and each man pushes his own block over to the inside. As in the case of all time records it is necessary that a clerk should watch to see that no one pushes more than one block.

At the top there are two openings through which the hours worked per day can be displayed, by means of a slide having such figures painted on it as may be needed. This, however, is not a necessary feature of the board.

Of course this does not have the advantage of making an autographic record like the time clock and the time must be taken off by a clerk leaving always a chance for a dispute, but for a temporary



DETAILS OF CHECK BOARD.

arrangement or one where the cost of a time clock is prohibitive it is a device to be recommended, and the size can be made to suit local requirements.

Railway Fire Protection Association.

The sixth annual meeting of the Railway Fire Protection Association will be held in the La Salle Hotel, Chicago, Ill., on November 18, 19 and 20, 1919. The meeting has been delayed beyond the regular annual date so that the members serving as fire prevention and accident prevention officers, during the month of October, would not be free to devote their time in helping to conduct the special campaign in connection with the national railroad accident prevention drive.

Return of British Railway Equipment.

The British rolling stock transferred from British railways and sent abroad during the war comprised 529 locomotives, 30,021 wagons, 31 ambulance trains and 16 other trains. Up to last month 439 of the locomotives and over 3,000 wagons and 13 of the trains had been returned. The return will be completed in a short time.

American Locomotive Company.

The Chester Works of the American Locomotive Company will be extended so that the capacity of the works will be more than doubled. The outlay for the necessary additions will cost over $1,000,000, and the output will be raised from 1,100 to 2,400 tons of finished castings per month.

Items of Personal Interest

T. F. Ryan, division foreman of Santa Fe at Las Vegas, N. M., has been appointed master mechanic at Raton, N. M.

A. H. Kendall has been appointed master mechanic of the Quebec district of the Canadian Pacific, succeeding C. A. Wheeler, transferred.

G. P. MacLaren has been appointed district engineer of the Ontario district of the Canadian National railways, with headquarters at Toronto, Ont.

G. H. Greer, storekeeper of the Yazoo & Mississippi Valley, Miss., has been appointed storekeeper of the Gulf, Mobile & Northern, with office at Mobile, Ala.

Henry Blanchard has been appointed representative of the Baldwin Locomotive Works, with offices at 908 Merchants' National Bank Building, St. Paul, Minn.

W. H. Woodin, president of the American Car & Foundry Company, has gone on an extended tour in Europe to investigate the equipment needs of the allied countries.

A. S. Abbott, master mechanic of the Frisco System at Springfield, Mo., has been appointed supervisor of tools and machinery of the entire system, with headquarters at Springfield.

S. D. Dimond has been appointed chief electrician on the Minneapolis, St. Paul & St. Sault Ste. Marie, with headquarters at St. Paul, Minn., succeeding J. R. Smith, appointed signal supervisor.

B. F. Kuhn, master mechanic on the New York Central lines west of Buffalo, at Ashtabula, Ohio, has been appointed assistant superintendent of motive power, with headquarters at Cleveland, Ohio.

C. S. Ogilvie, assistant engineer on the Grand Trunk, with headquarters at Ottawa, Ont., has been transferred to the Montreal division, with headquarters at Montreal, Que., succeeding G. Murgatroyd.

Colonel Frederick W. Green, assistant to the president of the St. Louis Southwestern, and the St. Louis Southwestern of Texas, has been appointed vice-president of these companies, with headquarters at St. Louis, Mo.

C. E. Brooks, master mechanic of the Chicago, Milwaukee & St. Paul at Lewiston, Mont., has been transferred to Miles City, Mont., and W. W. Lidell, master mechanic at Miles City, has been transferred to Lewiston.

J. E. Fanning, resident engineer of the Illinois Central, with headquarters at Golconda, Ill., has resigned to become chief engineer of the Gulf & Ship Island, and the Mississippi Central, with headquarters at Hattiesburg, Miss.

J. J. MacGinn, formerly master mechanic of the Cincinnati Northern at Van Wert, Ohio, has been appointed superintendent of motive power of the Lake Erie & Western, with headquarters at Lima, Ohio. succeeding George J. Duffy, deceased.

L. L. Sparrow, office engineer of the Atlantic Coast Line, with headquarters at Wilmington, N. C., has been appointed principal assistant engineer with headquarters at Wilmington, and George G. Thomas, Jr., assistant engineer, succeeds Mr. Sparrow as office engineer.

L. R. Wink has been appointed assistant superintendent of the Chicago & Northwestern, with offices at Chicago, and C. J. Nelson has been appointed general foreman of the car department in charge of the Galena and Wisconsin divisions and Chicago terminals, succeeding Mr. Wink.

F. W. Boardman has been appointed fuel supervisor of the Texas & Pacific, the Trans-Mississippi Terminal, the Weatherford Mineral Wells & Northwestern, the Gulf Texas & Western, the Denison & Pacific Suburban and the Fort Worth Belt railroads, with headquarters at Dallas, Texas.

R. W. Lipscomb, assistant superintendent on the Galveston, Harrisburg & San Antonio, at El Paso, Tex., has been appointed chief assistant mechanical superintendent on the Southern Pacific Louisiana Lines and Texas Lines, with headquarters at Houston, Tex., succeeding, J. P. Nolan, retired on pension.

Lieut. Leigh Budwell, having returned from service in the Transportation Corps in France, where he served as master mechanic in the 16th Grand Division, has resumed his duties as mechanical engineer of the Richmond, Fredericksburg & Potomac and the Washington Southern, with headquarters at Richmond, Va.

Captain John Maher, Captain George B. Farlow, Captain Joseph M. Lewis, Captain Paul W. Elmore, Lieut. W. B. Maurer and Lieut. J. D. Stemm, having been honorably discharged from military duty, have resumed their positions as assistant engineers on the Baltimore & Ohio, Lines West, with headquarters at Cincinnati, Ohio.

F. M. Crandall, assistant master mechanic on the New York Central Lines west of Buffalo, with office at Collinwood, Ohio, has been appointed master mechanic with headquarters at Ashtabula, Ohio, with jurisdiction over the Franklin division including the Oil City branch, Ashtabula and Youngstown yards, and the Alliance division.

Harry M. Giles, has been appointed general superintendent of the South Philadelphia works of the Westinghouse Electric and Manufacturing Company. Mr. Giles for a number of years past has been superintendent of Marine erection, a position to which he was appointed by U. T. Herr, when the Electric Company absorbed the Machine Company. It is interesting to note that Mr. Giles' father, Charles E. Giles, a well-known mechanical engineer has been for thiry-five years shop superintendent of the Corliss steam engine shops, Providence, R. I., and during his apprenticeship there worked on the lathe on which were completed the turret rings of the "Monitor," the novel war craft that defeated the Confederate cruiser "Merrimac" at Hampton Roads during the Civil War.

OBITUARY.

Charles M. Jacobs.

The death is announced of Charles M. Jacobs, an eminent engineer, at London, England, on September 7, in his seventieth year. Mr. Jacobs was consulting and chief engineer on several of the leading railroads in America, among other works he designed plans for connecting the Pennsylvania and Long Island railroads, and also the complete system of railway tunnels under Manhattan Island and vicinity. He was also consulting engineer for the construction of the tunnel under the River Seine at Paris, France. He was prominently identified with the leading engineering societies in America and in Great Britain.

Thomas L. Morton.

Thomas L. Morton, for many years principal assistant engineer of the Atlantic Coast Line, with headquarters at Wilmington, N. C., died on August 27, aged 65 years. He was engineer in charge of the location and construction of parts of the Plant System in the early eighties, and completed the construction of the line from Tampa to Kissimmee, Fla. When the Plant System was acquired by the Atlantic Coast Line, Mr. Morton was engaged in the engineering department, his period of service in the companies extending over 36 years.

George W. Prescott.

One of the very few remaining pioneers of Western railroading, George W. Prescott, died at his home, Highland, San Bernardino County, California, on September 22, 1919. Mr. Prescott was born March 29, 1833 and entered railroad service as a waterboy on the construction of the Northern and New Hampshire Railroad between White River Junction and Concord in 1845, and later became a fireman and engineer. In 1855 he was an engineer on the old Scioto Valley Railroad, and in 1857 became master mechanic of the Mobile & Ohio Railroad. At the outbreak of the civil war he moved North as a foreman on the Chicago, Milwaukee and St. Paul under George Hackney, who was the first superintendent of motive power of the Santa Fe. In 1870 he became fuel agent of the Michigan Central, and in 1874 was on the Chicago & Lake Huron and the Chicago & Grand Trunk at Battle Creek, Mich. In 1879 he returned to the Cairo & St. Louis and was superintendent of motive power of the Texas & St. Louis in 1881. At the time of his retirement from railroad service in 1895, Mr. Prescott was superintendent of the motive power and car department of the California lines of the Santa Fe.

Mr. Prescott was an early advocate of the straight tired wheel, claiming that no material advantage was gained, inasmuch as it is impossible to cone wheels to adapt themselves to all degrees of curvature, besides having the disadvantage of bearing hard against the rail and making sharp flanges. He admitted at the same time that the coned wheels curved slightly easier, but did not retain the perfect cone for any length of time.

Master Car and Locomotive Painters' Convention.

The forty eighth convention of the above association was held in Chicago on September 9th. Interesting technical papers were submitted and discussed, and it was unanimously agreed after due consideration to amalgamate with the American Railroad Association, as a division of the mechanical section.

Books, Bulletins, Catalogues, Etc.

The Story of the Old Colony Railroad, by Charles E. Fisher, Taunton, Mass. 196 pages, with numerous illustrations. Price, $3.50.

This work will take a high place among the few authentic records of the early development of railroads in America. It is now twenty-five years since the Old Colony ceased to be an active corporation. In America railroads may be said to have had their inception coincidentally with the first railroad in Great Britain. While the Liverpool & Manchester Railroad was being contemplated, the work was begun on a railroad from Quincy, Mass., to the nearest tidewater, about 4

miles in length, and cars were running on October 7, 1826, conveying granite used in the construction of the Bunker Hill Monument. From this noble beginning the good work went on, and from whatever point of view we regard early railroading in New England, it will be universally admitted that in point of corporate management it was a model of commercial integrity, while in the development of motive power and rolling stock the results were altogether admirable. The story is interestingly told in Mr. Fisher's book. The record is illuminating. The data is exact. The illustrations are of genuine historical value. The paper and letterpress are of the best.

Fuel Saving on Railroads.

A carefully tabulated report of fuel consumption, freight and passenger train service of loads under the control of the United States Railroad Administration, has just been issued by direction of Eugene McAuliffe, manager. The report covers 79 per cent of the total mileage under the control of the Administration, and for the last six months previous to July 1, 1919, the saving of fuel in freight train service totaled 9.5 per cent, as compared with the same period in the previous year, and in passenger train service a saving of 10.5 per cent, the estimated savings combined for all roads on both passenger and freight service, yard service excluded, approaches $18,000,000. The largest saving in freight service was obtained on the New England district of the Eastern region, and the highest saving in passenger service occurring in the Central Western regional district.

American Railway Equipment for Far Eastern Roads.

A book on railway equipment of far eastern railroads, has just been issued by the Department of Commerce with special reference to China, Japan, Korea and the Philippine Islands. In China especially there are, and will continue to be, exceptional opportunities for the sale of American locomotives, cars, and all kinds of equipment. The author has discussed the location and extent, traffic, organization, equipment and purchasing methods of every important railway in the countries mentioned, and has made many valuable suggestions and recommendations. The book contains 339 pages, with 46 illustrations and a map. Copies may be had from the Government Printing Office, Washington, D. C. Price, 35 cents.

The Mining Industry.

The programme of dedication of the Pittsburgh experiment station is the subject of a finely illustrated pamphlet issued by the Bureau of Mines, Washington, D. C. The ceremonies were of an unusually interesting kind and occurred on September 29, 30 and October 1. The new laboratories cost over $1,000,000, and are the most complete of their kind, covering, as they do, the entire field of the mining industry, looking especially toward the prevention of waste. Of special interest to engineers will be a complete study of the performances of various types of steam boilers. An investigation of what actually happens in the combustion space of a powdered-coal-burning furnace is being already carried on. A Westinghouse underfeed stoker is also being tested.

Approximating Metal Weights.

For the rough approximation of the weight of various metals it may be taken that the bulk of 1 lb. of the following will be about that stated, some variations occurring according to content and state. Aluminum 10.2575 cubic inches, copper 3.109 cubic inches, gun-metal 3.148 cubic inches, cast iron 3.8 cubic inches, wrought iron 3.6 cubic inches, lead 2.437 cubic inches, and steel 3.53 cubic inches.

Railway and Locomotive Engineering

A Practical Journal of Motive Power, Rolling Stock and Appliances

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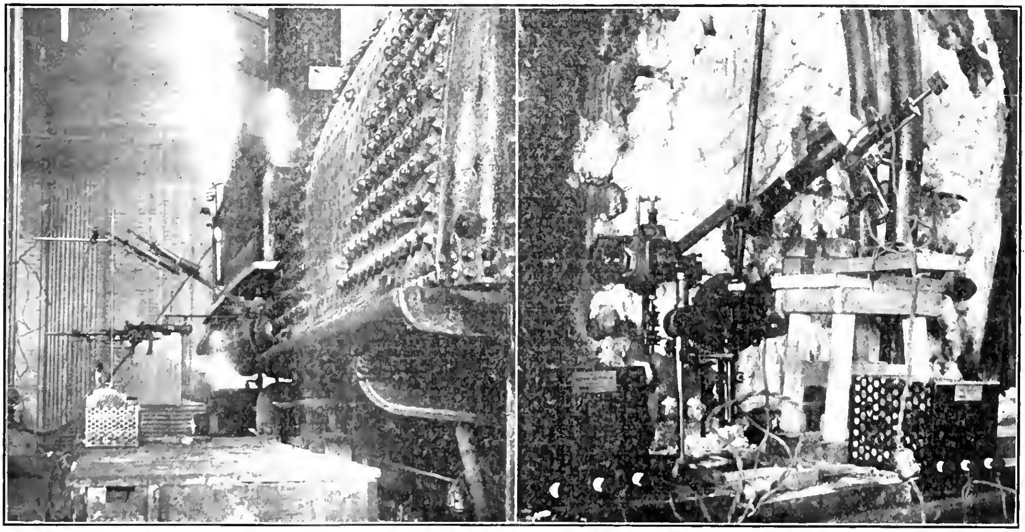
The Deflection of Staybolts

By Geo. L. Fowler

For many years the breakage of staybolts in locomotive boilers has been a source of danger and this danger was emphasized very shortly after the locomotive took its rapid leap ahead in size when it was found that it was no longer necessary to limit firebox dimensions to when the boiler was working under normal conditions, the staybolts were straight, in their normal position and were subjected only to that stress which would be imposed upon them by the steam pressure acting upon the plates. It was further assumed or guessed that the deflection of way of experimental investigation, was to determine that, under certain conditions, there was an up and down movement of the crownsheet and the tubes.

The object of the investigation, about to be described, was to determine, by actual measurement, the amount of rela-



REDESIGNED APPARATUS APPLIED TO WOOTTEN FIREBOX. ORIGINAL APPARATUS APPLIED TO RADIAL STAYED FIREBOX.
APPARATUS FOR MEASURING STAYBOLT DEFLECTION IN SERVICE.

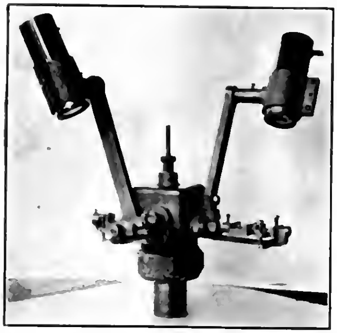
the space available between driving axles and frames. The increase in length of firebox produced a corresponding increase in staybolt breakages. It was assumed that this breakage was caused by the bending of the staybolts due to a variation in the expansion of the two sheets which they connected, by which they were strained beyond their elastic limits, thus producing a progressive fracture. It was also generally assumed that, the bolts occurred during the process of raising steam, and that, because the breakage occurred at the ends of the firebox, there was a neutral vertical zone at the longitudinal center of the firebox along which there was no staybolt deflection. But, while assumptions and theories were as plentiful as autumn leaves, no one had any data on the subject and no one knew.

The most that had been done, in the tive movement between the inner and outer sheets of a locomotive firebox, also when that motion occurred, as well as its general character.

At the outset there was no precedent upon which to proceed, nor anything more than the vaguest of guesses as to the amount of motion to be looked for, except that it would probably be very slight.

The apparatus used was of a very sim-

ple character and involved but one moving part. Its work consisted of resolving the motion of the inner sheet relatively to the outer one, into its vertical and



ORIGINAL APPARATUS FOR MEASURING STAYBOLT DEFLECTION.

horizontal components and projecting them on a screen and these were afterwards recombined to plot this relative movement in the form of a diagram. The mechanism of the apparatus consisted of two small metallic mirrors that were first adjusted to perfect parallelism. A beam of light from a narrow slit was by them reflected back to a screen. One mirror was fastened rigidly to the outer sheet and traveled with it, and remained parallel to it at all times. The main body of the apparatus, including all lenses and adjustments, was also attached to this same sheet. The second mirror was suspended on the main body of the apparatus, but was so connected to the inner sheet that if any motion took place between the two sheets the mirror would be rotated. This would cause a separation of the two sections of the beam of light on the screen and the amount of this separation was the measure of the relative movement of the sheets. The calculation of the motion was simply dependent upon the distance at which the screen was set from the mirrors.

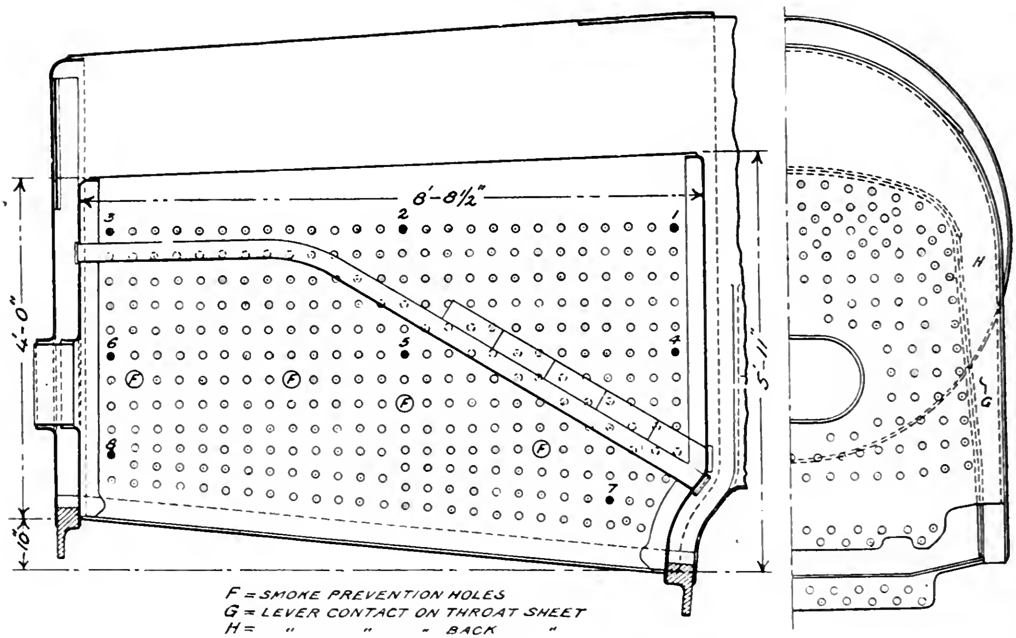
The first setting was such that a separation of 1/16 in. indicated a relative movement of 1/20,000 in. between the two plates. This was found to give finer measurements than were needed and the whole of the work, hereinafter detailed, was done with the screen so set that each 1/16 in. separation of the beams of light indicated a relative movement of 1/6,400 in. between the plates.

The first boilers subjected to investigation were of the radial stayed type, as illustrated in the accompanying engravings. There were two of them that were identical in construction except that one was fitted with a complete installation of the ordinary rigid staybolts and the other with a complete installation of the Tate flexible staybolts as made by the Flannery Bolt Co., of Pittsburgh, Pa.

The firebox dimensions were:
Length at bottom 8 ft. 3 in.
Length at top 8 ft. 8½ in.

SCREEN FOR MEASURING LIGHT BEAM MOVEMENT.

Width at bottom 5 ft. 2 in.
Width at top 4 ft. 8 in.



RADIAL STAYBOLT FIREBOX, LAKE SHORE & MICHIGAN SOUTHERN RY

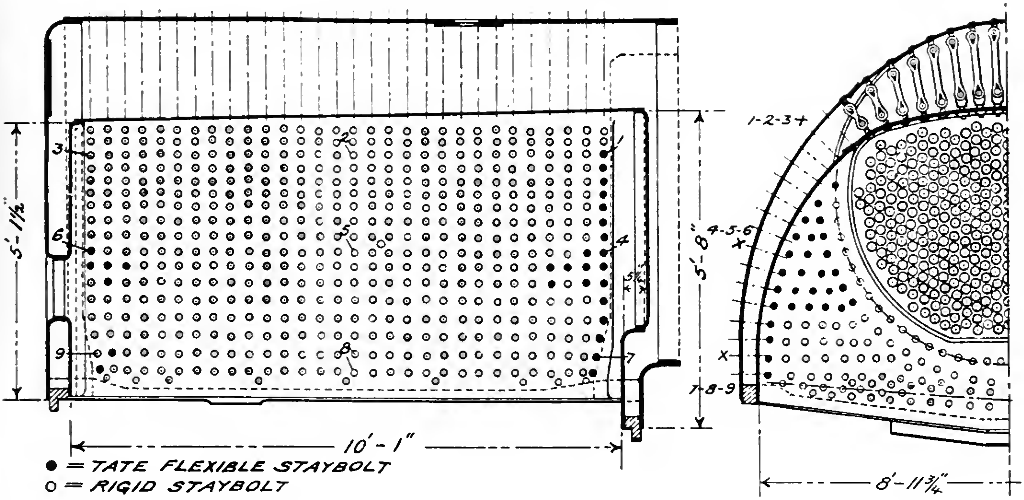
The general construction is shown in the accompanying print. Each firebox was fitted with four water tubes for carrying a brick arch which was located as shown. New fireboxes had been placed

in each of the boilers immediately prior to the tests so that all sheets affected were fresh and clean.

The scope of the investigation was as follows:

A determination of the temperature of the fire and water sides of the inner firebox sheet at the side at five points.

A determination of the temperatures of the water in the throat at the foundation ring and in front of the arch tube openings, while steam was being raised in the boiler and while it was at work.

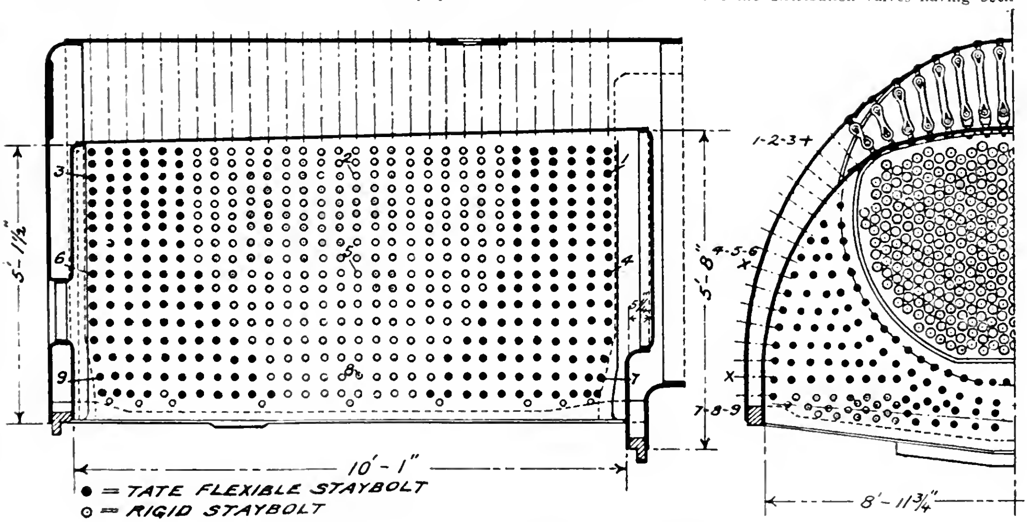


RIGIDLY STAYED WOOTTEN FIREBOX, DELAWARE & HUDSON CO.

A determination was made of the difference in the movement of the inner and outer sheets of the firebox at eight points.

A determination of the difference in the movement of the crownsheet relatively to the roof sheet; of the back firebox sheet relatively to the back head; of the throat sheet relatively to the front tubesheet and of the front tubesheet relatively to the shell.

Two methods of conducting the tests were employed. In one the fire was kindled and the fireman was instructed to proceed with the raising of steam in the usual manner, employed in regular roundhouse work. When the steam pressure was up so that the safety valve opened, the fire was maintained so as to keep them blowing for from 10 to 20 minutes, when the fire was dumped and the boiler allowed to cool. The time required to raise the steam to the blowing-off point varied from 50 to 90 minutes.



FLEXIBLY STAYED FIREBOX, DELAWARE & HUDSON CO.

The second method was the same as the first in so far as the raising of steam pressure is concerned; but, when this was done the distribution valves having been removed from the locomotive, the throttle valve was opened and, with the injector running to capacity, the fire was maintained so as to hold the steam pressure at the blowing-off point, which was

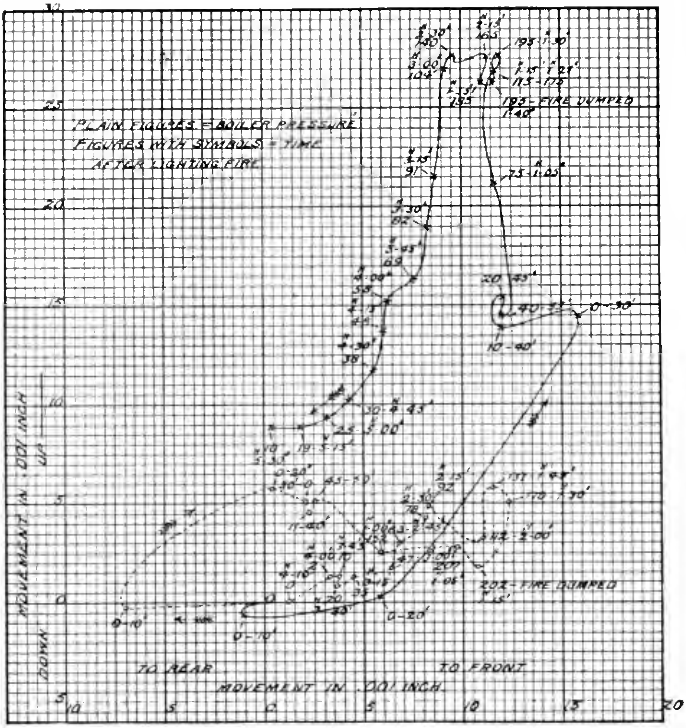
at 195 lbs. per sq. in. This was done for about one-half hour, at the end of which time the fire was dumped and the boiler cooled.

In raising steam the shop blower, carrying a pressure of about 60 lbs. per sq. in. was attached to the locomotive and kept in use until the boiler pressure reached that amount, after which the regular locomotive blowers were used.

In cooling the boiler the steam was blown out through the blowers so as to cause a fall of pressure of about 1 lb. per

In the tests at Staybolt No. 1, which was at the front upper corner of the firebox, the first method of testing was used, and the results obtained are shown in the diagram. In this, as in all diagrams to follow, the scale of movement is in thousandths of an inch, on either side, vertically or horizontally, of the starting point at 0 which denotes the normal position of the two sheets when the boiler was cold at the commencement of the test.

In the first test at Staybolt No. 1, it



Maximum Deflection Flexible Staybolt .03 in.; Maximum Deflection Rigid Staybolt .0132 in.
DEFLECTION OF STAYBOLTS No. 1; RADIAL STAYED BOILERS—LAKE SHORE & MICHIGAN SOUTHERN RY.

minute by which it required about three hours to reduce the pressure to zero.

In making the tests the apparatus was successively located at the staybolts marked Nos. 1, 2, 3, 4, 5, 6, 7 and 8.

Lack of space will make it impossible to enter into the details of all of the work done, and only enough of it will be described as will be needed to give an idea of what was learned and the basis for the tentative conclusions that have been reached. I say "tentative," because the investigation has not yet been completed and full information is not available as to how all kinds of fireboxes act in service. The reasons for this will appear as the description proceeds.

will be noticed that the initial movement of the inner sheet relatively to the outer one was down and to the rear, and it will be seen afterwards that this initial downward movement was characteristic of nearly all of the tests. Both the downward and rearward movements were, however, quickly reversed and the inner sheet moved up and to the front.

There are features brought out in this diagram that are characteristic of all of the others and to which attention may be called here. One is that the sheets do not expand and return to their normal positions when the steam pressure is raised; a second that the sheets are in constant motion relatively to each other at all times and that the relative motion is much greater with a boiler fitted with flexible stays than it is with one having rigid stays.

In the case of Staybolt No. 1 this difference in movement is very marked and the total maximum deflection of the flexibly stayed boiler is more than twice that of the rigidly stayed, while, if the variation of vertical movement alone is taken into consideration, that of the flexibly stayed boiler is more than five times as great as that of the rigidly stayed. It will be seen, too, that there is a general progressive movement until the blowing-off pressure is reached, then, while that is being maintained, there is a movement of the sheets to and fro, with a general return movement towards the original normal position after the fire has been dumped and until the boiler had been cooled to the disappearance of all pressure.

In this first diagram, the rigidly stayed sheet returned to within about .001 in. of its original position, while the flexibly stayed sheet was out about .009 in. at the conclusion of the test.

Owing to the fact that, in the rigidly stayed boiler, the breakage, at the upper front and back corners of the side sheet, was much greater than it was midway between the two, it has been assumed that there was a neutral point on this midway line, on which the staybolt deflection was little or nothing. That this surmise was approximately correct is shown by the diagram of the tests made at Staybolt No. 2, which was at the center of the upper row.

Here, in both the flexibly and rigidly stayed boiler, we find that the horizontal motion was much less than the vertical, indicating an approach to a neutral zone, but, as at Staybolt No. 1, we find the horizontal movement of the sheet to be something more than twice as much on the flexibly as on the rigidly stayed boiler.

It is impossible to state positively that there is no neutral line with the rigid boiler. But it can be made with all positiveness regarding the flexibly stayed boiler, that there is no fixed neutral line. Of course, if the front end of the inner sheet goes to the front and the back end to the rear there is possibly, an instantaneous neutral line, but it must be in constant motion, and, therefore, does not fulfill the preconceived ideas as to the neutral line. From a study of the curves of movement of the staybolts examined on the rigidly stayed boiler, the evidence is that the same holds true for that boiler, namely, that the point of no movement, that is where the two sheets occupy their original or normal positions, is in constant motion to and fro. This means that all staybolts are being constantly bent back and forth, which is corroborated by the determinations of sheet tem-

peratures which formed a part of this investigation.

In the case of staybolt No. 3, which was at the back end of the top row and close to the back head, there was a sudden and rapid movement of the inner sheet to the rear on both the rigidly and flexibly stayed boilers, and the maximum of the horizontal movement was reached in a very short time after the kindling of the fire; the rigidly stayed boiler reaching it in ten and the flexibly stayed in twenty minutes.

Without going into the details of the other tests, it may be stated that while the amount of movement varied, the real character of the motion did not vary essentially and the same relationship between the rigidly and flexibly stayed boilers was maintained.

When tests were made at the next to the bottom row of staybolts, however, a matter developed that proved to be of very great importance.

Attention has already been called to the fact that in the test at Staybolt No. 1 the first apparent motion of the sheet was downward. But as this amounted to only .00075 in. it was regarded as a negligible quantity. At the bolt below it (No. 4) there was a drop of .00225 in., which was still not enough to excite suspicion, but when at No. 7 this drop increased to .009 in. it was evident that something was the matter. Here was an apparent downward movement of the inner sheet at a point only a few inches above where it was riveted to the foundation ring. Evidently an impossibility, and the only explanation to be made was that the sheet buckled and, by throwing the apparatus out of line, caused it to indicate a downward movement when none such occurred.

Accordingly these first tests must be regarded as showing but two things: the constant movement of the staybolts while in service and the relative movement of the sheets of a rigidly and flexibly stayed boiler.

With no precedent to serve as a guide the apparatus had been designed on the assumption that the two sheets would remain parallel to each other at all times. When this evident buckling was discovered the apparatus was redesigned so as to indicate not only the movement of the sheets, but any buckling that might take place.

This redesigned apparatus was used on some Wootten boilers having a firebox design shown in the accompanying engraving.

The general dimensions of the boilers were as follows:

Length, 10 ft. 1 in.

Width at foundation ring, 8 ft. 11¾ in.

Height at front, 5 ft. 8 in.

Height at back, 5 ft. 1½ in.

Depth of combustion chamber, 5¼ in.

Number of 2 in. tubes, 411.

Length of tubes, 14 ft. 6 in.

Inside diameter of shell (front), 6 ft. 1 in.

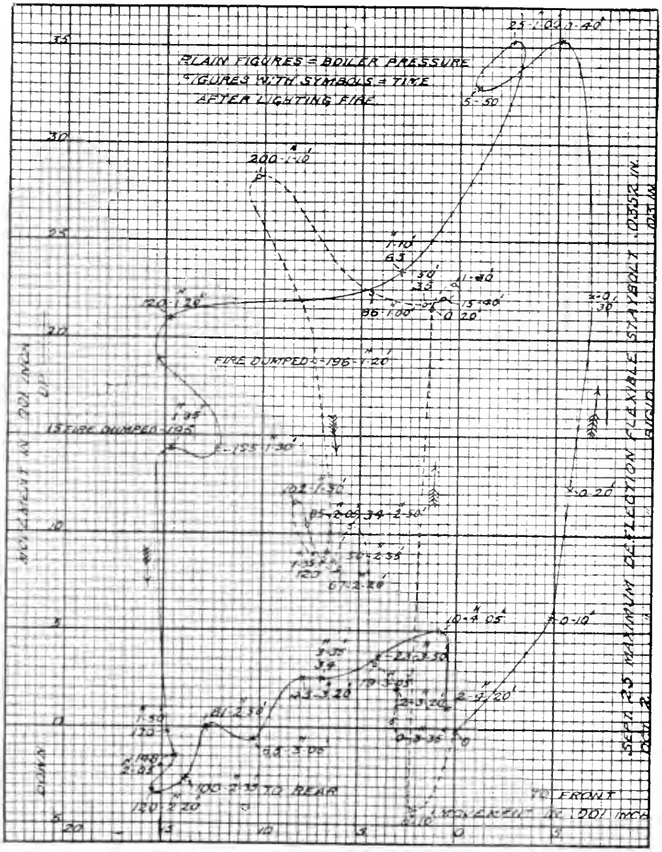
Height of room over crown (front), 1 ft. 6¾ in.

Height of roof over crown (rear), 1 ft. 9½ in.

There were three rows of expansion stays at the front to hold the crown sheet, eight on each side of the center line, as shown in the drawing. The staybolts were spaced four inches center to center and were ⅞ in. in diameter for the rigid bolts.

for repairs, the location of which are shown in the drawing.

The other boiler which is designated as the flexibly stayed boiler, had a complete installation of flexible staybolts in the throat sheet, with the exception of twenty bolts near the foundation ring that were rigid as shown in the drawing. In the side sheet out of a total of 510 staybolts, 248 were Tate flexible bolts. These were located in equal numbers and with the same arrangement at the front and back ends of the firebox. There were



DEFLECTION OF STAYBOLTS NO. 2, TOP ROW CENTER—RADIAL STAYED BOILERS. LAKE SHORE & MICHIGAN SOUTHERN RY.

The two boilers were not distinctly flexibly and rigidly stayed as were those used in the first tests. The boiler which has been designated as the rigidly stayed had a number of Tate flexible staybolts, as indicated in the drawing. In the throat sheet all of the bolts in the seven upper rows and all of the bolts in the outer row were flexible. In the side sheets there were fifteen Tate flexible bolts in the front row and twelve scattering Tate bolts that had been put in

six in the top horizontal row next the crownsheet, with a gradual increase from the top to the bottom as shown in the drawing and photograph. This left a wide section of firebox at the center that was stayed by rigid bolts and which evidently exerted an important influence on the results as will be pointed out later.

The staybolts at which the tests were made were located at the numbered points 1 to 9 on the two drawings, and the tests

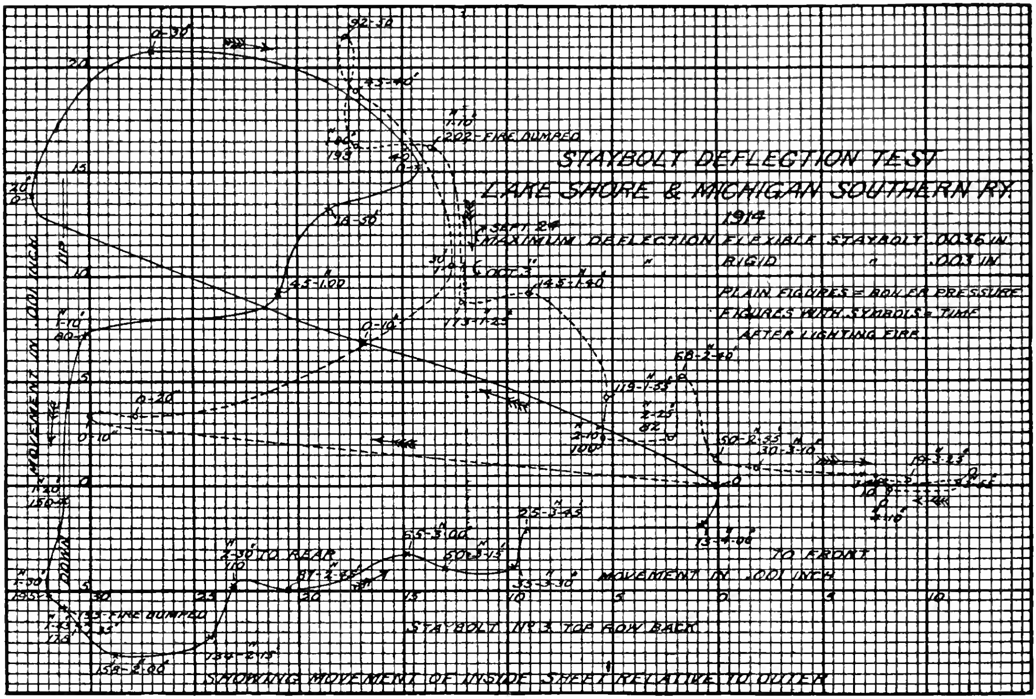
were made as before, by raising steam, holding the throttle valve open for thirty minutes and then blowing down at the rate of 1 pound per minute, readings of the sheet movements having been made, during the whole period, at 10-minute intervals.

Whether it was because the apparatus used on the radially stayed boilers only indicated the apparent motion of the sheets, while that used on the Wootten boilers indicated the actual movement, that the diagrams of these movements is much more complicated for the latter boilers, cannot be stated positively. That the buckling that evidently did occur in

The diagram for the corresponding staybolt of the Wootten boiler is a mass of knots and loops and back doubling from the start. This is especially true of the period prior to the development of the first steam pressure. This appeared at the point marked O-2H-10' on the diagram when the steam began escaping from the whistle valve. Then there was a rapid movement for 20 minutes until a pressure of 75 pounds was reached followed by an equally rapid forward and downward movement during a quick building up of the pressure to 200 pounds. Then there came a quick recovery horizontally during the period that

Then, when the throttle valve was opened, there was a rapid increase of firebox temperature resulting in a corresponding increase in the temperature of the gasses in the tubes and of the tubes themselves, which again pushed the tubesheet to the rear, carrying the front end of the firebox with it. Then followed the looping and doubling of the movement during the cooling down ending with the staybolt a little more than .002 in. from its original position.

In the rigidly stayed boiler the entanglement of the line of the movement is equally marked and is of the same general character; but, as in the other cases,



the sheets of the radially stayed boilers had its effect on the actual movement of the sheets is a reasonable supposition. But certainly there is a great difference in the character of the two.

Let us compare those for staybolt No. 1, in the two types of boilers.

In the radial stayed boilers there is a steady even motion of the sheet with little or no doubling back and looping over itself. There was a constant movement, to be sure, but it was, in the main, a progressive movement ending in an apparent deflection of about .008 in. from the starting point of the flexibly stayed boiler.

The rigidly stayed boiler was a little more complicated in its motion, but still not at all tangled, and ended with a deflection of a little more than .001 in. from the start.

the throttle valve was open, with only a very slight change in vertical position between the beginning and the end.

This movement is easily eplicable if the tube action as indicated by other tests, is taken into consideration. It was found that during the early period of raising steam, the tubes were heated more rapidly than the shell, with the result that the back tube sheet, and with it, probably, the front end of the firebox, was pushed to the rear. This explains the slight rearward movement of staybolt No. 1, at the starting of the test. Then, as the water became heated there was a tendency towards equalization of the temperature of the tubes and the shell. This resulted in a relative forward movement of the tubesheet permitting the firebox to expand normally.

the amplitude of the movement is much less.

This holds throughout the whole range of the work, varying in amplitude with the location of the staybolt and the method of staying. In general the amplitude was greater at the ends and upper portions of the firebox than at the center and lower portions.

There is another matter in connection with the rigidly stayed boilers that does not fully appear in the diagrams.

The evident reason for the lesser deflection of the rigidly stayed boiler is that it is rigid. The staybolts tend to hold the sheets in one position and resist all tendency to move, and this manifests itself in the jerky character of such motion as takes place. That is to say, there are sudden variations in the dis-

tance from the original position, variations of increase and decrease, which indicate that the stays resist the effect of the expansion of the sheets to move them, possibly buckling the sheet and then, when the pressure becomes more than they can carry, they suddenly yield.

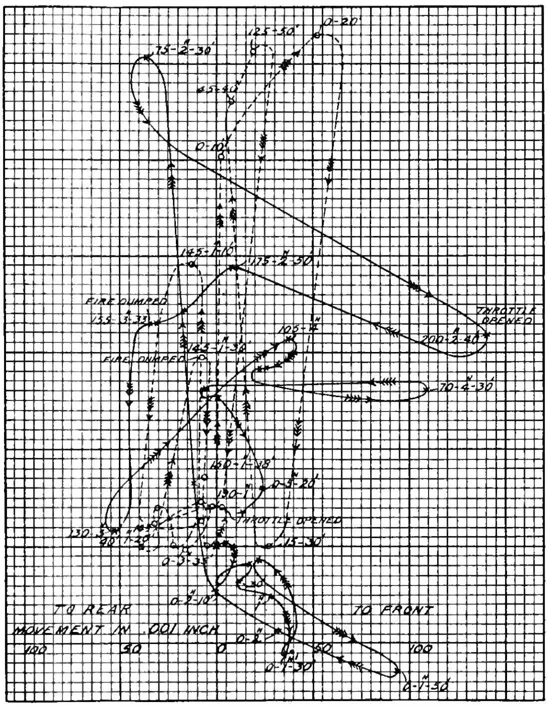
The one point where a close comparison and check between the radially stayed and Wootten boilers is possible is in the movement of the staybolts when the boiler is in service. In both cases it was found that the sheets were in constant motion relatively to each other from the instant the fire was built until the boiler was cold. Also the amplitude of the movement was much greater in the flexibly stayed boiler than in the rigidly.

The character of the movement was, however, apparently quite different in the two types of boilers. There was more bending to and fro in the Wootten as well as a much greater amplitude of motion. This is especially manifest in staybolt No. 1, where the maximum deflection of the flexible bolt in the Wootten boiler was about five times that of the radially stayed, and this amount entirely in a vertical direction.

Now, there may have been several reasons for this. In the first place, the Wootten firebox was 1 ft. 4½ in. longer and 1 ft. 1½ in. deeper and the staybolt was 8 in. long, as against 5¾ in. for the radially stayed boiler. Each of these items would tend to increase the deflection, while the comparatively small amount of horizontal deflection is explicable from the fact that there was a complete installation of flexible bolts in the radially stayed boiler, while, in the Wootten boiler there was a line of 18 rigid bolts in the central section that tended to stiffen the boiler and prevent a relative movement of the sheets.

These are set forth as suggested reasons, not as demonstrated proofs.

The main fact, however, stands out very prominently that the character and amount of the staybolt deflection is quite different in the two boilers. While as yet, there is not sufficient data accumulated to be able to state definitely as to just why this is so, and what should be done to the general design of one or both of the boilers to put the least possible strain on each.



Maximum Deflection Rigid Staybolt .2394 in.; Maximum Deflection Flexible Staybolt .2574 in.

DEFLECTION OF STAYBOLTS No. 1, TOP ROW FRONT; WOOTTEN BOILERS, DELAWARE & HUDSON CO.

In the matter of the buckling of the sheets caused by the combined action of sheet expansion and resultant staybolt deflection, it was found that the buckling was more with the flexible than with the rigid bolts; but, it must be borne in mind, the deflection was also greater, and a study of the details, shows that the ratio of the buckling of the flexibly stayed to the rigidly stayed was less than the corresponding ratio of deflection. In other words, given a fixed amount of staybolt deflection the buckle put in the sheet would be less with a flexible than with a rigid staybolt.

While at work on the Wootten rigidly stayed boiler, an attachment was made in a space just ahead of the No. 5 staybolt. As might have been expected, the actual movement of the sheet was about the same as at the No. 5 staybolt, but there was less buckling. This developed the probability that, in this long and wide firebox at least, the whole sheet, while under steam pressure, assumes a series of shallow corrugations that hold it out of alinement with its original shape, and which are sweeping over it in waves, as it were, according as the sheet expands or contracts. The depth of the corrugations is slight and the angle made by the side of the same with the original line of the sheet is never as much as one degree. The greatest angle obtained with these Wootten boilers was 48 minutes 52 seconds with a general average for all points tested on the flexibly stayed boiler of 7 minutes 29 seconds.

It is also possible that the buckling of the sheet might be appreciably decreased by a change in the original adjustment of the flexible staybolts, and also that there might be an increase in the deflection of the bolts. The suggested methods of accomplishing this is to give a little more play in the head of the bolt and the allowing of a little slack under the heads in the first place. This would permit of an easier adjustment to the movement of the sheet during the period of raising steam, when there is no load on the bolt, and the allowance of a little freedom of angular motion when the sheet and bolt are under strain.

There were other matters taken up in connection with this investigation for which there is no space to deal with in full at this time. There were the effects of the admission of cold air to the firebox on sheet temperatures and the apparent lack of circulation in the water log.

The fundamental facts fully brought out were that the staybolt deflection is much greater in a flexibly stayed boiler than in a rigidly stayed boiler, that certainly during the whole period of operation and probably until the boiler temperature had reached that of the atmosphere the staybolt is in constant motion, as evidenced by the fact that, out of hundreds of measurements taken, there were no two consecutive measurements that were alike; that the two types of boiler construction (Wootten and radial-stayed) have quite different effects of staybolt deflection; and that firebox temperatures and the action of the tubes have a marked influence on staybolt deflection at the front end of the firebox.

These tests also showed, in a marked degree, the extreme sensitiveness of the plates to changes of temperature. For example, a cold boiler may be filled with water of any temperature from cold to boiling and there will be no relative motion between the sheets. But let the fire be laid and a piece of lighted waste thrown in to ignite it, and it has, thus far, been impossible to get a reading be-

fore the sheets would show a movement, though this has been done within ten seconds from the time of the ignition of the waste.

This investigation is confessedly merely indicative and **not** conclusive. The absence of any data upon which to estimate the probable movement and buckling of the sheets made a redesigning of the apparatus necessary, and the use of boilers with a mixed assortment of staybolts in the second case, gave results that would probably be greatly modified were boilers with complete installations to be used. But there is this indication, that the boiler will expand and the staybolts deflect if they have a chance, and that this chance is much greater with a flexible bolt than it is with a rigid one.

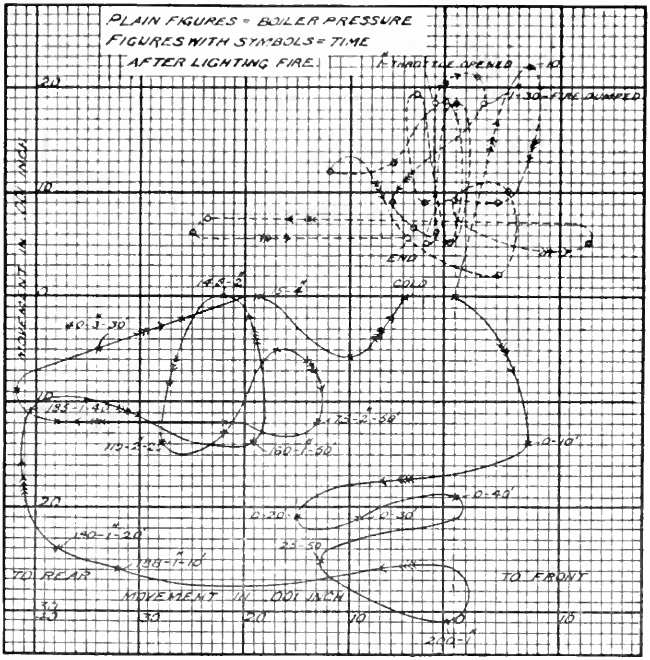
As has already been intimated, the difference in the conditions of operation of the apparatus makes a clean-cut comparison between the Wootten boiler and the wide firebox radial stayed boiler impossible, but one gets impressions and the impression left by the test is that the Wootten firebox is much more rigid than the wide firebox with the radial stays when rigidly stayed, and that if it were to be given a complete installation of flexible bolts the difference between the two would be very much greater than that indicated in these tests.

These variations explain the constant bending motion to which the bolts are subjected while the boiler is at work.

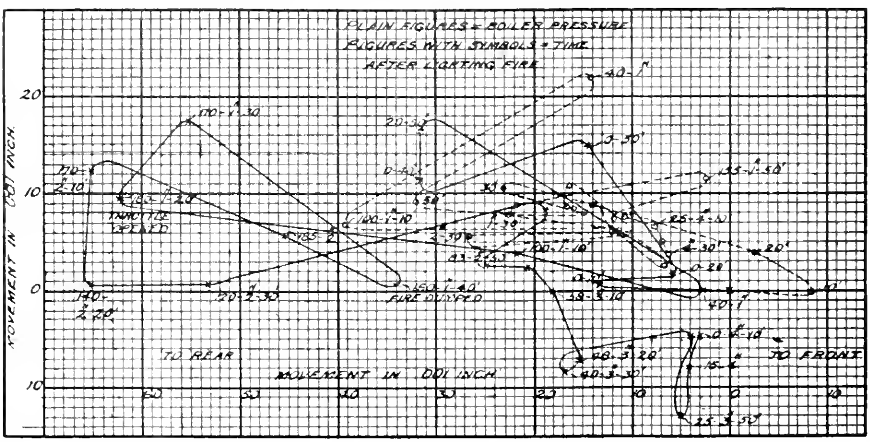
It naturally follows from this that a boiler which is so built as to permit the sheets to expand under the influence of temperature changes, will put less stress upon the staybolts and sheets than one where such freedom of motion does not exist. There is no reason to think that there was any great difference in the temperature of the sheets of the two boilers, and yet, as I have already indicated, there was a marked difference in the movements of the staybolts and the sheets. If a given change of temperature produces a definite change of dimension in the sheet, anything that prevents this change must itself be subjected to stress and must put a similar stress upon the sheets. Hence, so far as these investigations have been carried, they indicate the value of using the flexible in preference to the rigid bolt.

There is one point that cannot be expressed in cold figures, and that is the impression that this work makes upon observers.

In working over this matter night after night, and watching the delicate and sensitive movement of the sheets and staybolts and the difference in the action of the flexible and rigid bolts, everyone was greatly impressed with the superiority of the flexible bolt as a means of reducing the probable stresses that the several parts of the boiler are called upon to sustain. This is a purely personal matter that is shared by all who have been present during the progress of the work, and it has been driven home in a manner that is more than convincing, it is demonstrative of the desirability of flexibility in boiler construction



Maximum Deflection of Rigid Staybolt .0251 in.; Maximum Deflection Flexible Staybolt .045 in.
DEFLECTION OF STAYBOLTS No. 2, TOP ROW CENTER; WOOTTEN BOILERS, DELAWARE & HUDSON CO.



Maximum Deflection Rigid Staybolt .0483 in.; Maximum Deflection Flexible Staybolt .0658 in.
DEFLECTION OF STAYBOLTS NO. 3, TOP ROW BACK; WOOTTEN BOILERS, DELAWARE & HUDSON CO.

Metallurgy in the Manufacture of High Speed Steel

The aim of the manufacturer of high speed steel is to make a uniform metal that will best meet the requirements of the average machine shop on general work, and at the same time allow the widest variation in heat treatment to give desired results. High speed steel is one of the most complex alloys known. It contains approximately 24 per cent. of alloying materials, including tungsten, chromium, vanadium, silicon, manganese, and in addition to these there is often found cobalt, molybdenum, uranium, nickel, copper and tin. The steel to be within the range of generally accepted analysis should contain over 16 per cent. and under 20 per cent. tungsten. If of lower tungsten content it should carry proportionately more chromium and vanadium.

The combined action of tungsten and chromium in steel gives to it the remarkable property of maintaining its cutting edge at relatively high temperature. This property is commonly spoken of as "red-hardness." The percentages of tungsten and chormium present should bear a definite relationship to each other. Chromium imparts to steel a hardening property similar to that given by carbon, although to a less degree. The hardness imparted to steel by chromium is accompanied by brittleness. The chromium content should be between 3½ and 5 per cent.

Vanadium was first introduced in high speed steel as a "scavenger," thereby producing a more homogenous product, of greater density and physical strength. It soon became evident that vanadium when in larger quantities than necessary as a scavenger, imparted to high speed steel a much greater cutting efficiency. Recently no less an authority than Prof. J. O. Arnold, of the University of Sheffield, England, stated that "high speed steels containing vanadium have a mean efficiency of 108.9, as against a mean efficiency of 61.9 obtained from high speed steel without vanadium content." A wide range of vanadium content in high speed steel, from ½ to 1½ per cent., is permissible.

Sulphur and phosphorous are two elements detrimental to all steels. Sulphur caused "red-shortness" and phosphorous causes "cold-shortness." The pernicious effects of these two elements counteract each other to some extent, but the content should be not over .02 sulphur and .025 phosphorous. The general bad effect of small quantities of sulphur and phosphorous is due to their not being uniformly distributed, owing to their tendency to segregate. The detrimental effects of tin, copper, and arsenic are not generally realized by the trade. Small quantities of these impurities are exceedingly harmful. It is difficult for public chemists to analyze them. The manganese and silicon contents are relatively unimportant in the percentages usually found in high speed steels.

The chemical composition of steel for any purpose is a basic consideration and must be such as will meet the requirements, but the quality of the steel does not depend wholly upon the chemical composition, but to some extent upon local conditions surrounding the manufacture. Properly speaking it represents the highest art in the making of steel by tool steel practice. It is indeed an art aided by science. The human element in the manufacture of high speed steel is a decided factor, and steel manufacturers and steel treaters are more vitally interested in the changes that take place in the steel during the various processes of manufacture rather than a detailed description of those processes, that are more or less familiar to all.

In order that good high speed steel may be furnished in finished bars, it must be of correct chemical analysis, properly melted and cast into solid ingots, free from blow-holes and surface defects. Sudden changes of temperature are to be guarded against at every stage of the manufacture and subsequent treatment. Ingots of high speed steel are relatively weak, and the tendency to crack due to cooling strains is great. For this reason the hot ingots are not allowed to cool quickly, but are placed in furnaces that are of about the same temperature and are allowed to cool gradually before being placed in stock. Good high speed steel can be made only from good ingots. Steel treaters should be more vitally interested in the important changes that take place in high speed steel during the hammering operations than that of any other working that the steel receives in the course of its manufacture.

The making of the structure begins under the hammer, and generally speaking, high speed steel of good quality works well under the hammer. Ingots are first hammered into billets. The hammer blows should be heavy, so as to cause compression into the center of the billet; otherwise undesirable characteristics such as coarse structure and carbide envelopes will exist and cause the steel treater much trouble. Surface defects invisible in the ingot may be opened up under the hammering operation, in which event they are clipped from the hot billet. The billets are then carefully inspected and all surface defects ground or chipped. The hammered billets are again slowly heated and receive a second hammering, known as "cogging." The billet resulting therefrom is known as a "cogged" billet and is of the proper size for the rolling mill or for the finishing hammer.

The various factors governing the proper rolling of high speed steel are so numerous that it is necessary for each individual rolling mill to work out a practice that gives the best results upon the particular analysis of the high speed steel that they make. The heating and finishing temperatures, draft and speed of the mill must all be considered. There is no department of a tool steel plant where the personnel of the actual operators has a greater influence upon the quality of the finished product. It should be delivered from the rolling mill to the annealing department free from scale, for scale promotes the formation of a decarbonized surface. In the preparation of bars of high speed steel for annealing, the bars are packed in tubes with a mixture of charcoal, lime and other material. The tube is sealed and placed in the annealing furnace. The temperature of the furnace is gradually raised to about 1,650 deg. Fah., and held there for a sufficient length of time, depending upon the size of the bars. After very slow cooling the bars are removed from the tube.

As to the heat treatment of high speed steel, it is customary for the manufacturer to recommend to the user a procedure that will give to his steel a high degree of cutting efficiency. This cutting efficiency depends upon the thermal stability of the complex hardenites existing in the hardened and tempered high speed steel. The hardenites may be described as that form of solid solution which gives to high speed steel its cutting efficiency. They are produced by heating the steel to a very high temperature, near the melting point, which throws into solution carbides and tungstides, provided they have been properly broken up in the hammering process and uniformly distributed throughout the steel. By quenching the steel at correct temperature this solid solution is retained at atmospheric temperature.

The general practice of tempering high speed steel is almost uniformly towards the following: Slowly and carefully preheat the tool to a temperature of approximately 1,500 deg. Fah., taking care to prevent the formation of excessive scale. Transfer to a furnace, the temperature of which is approximately 2,250 to 2,400 deg. Fah., and allow to remain in the furnace until the tool is heated uniformly to the above temperature. Cool rapidly in oil, dry air blast, or lead bath. Draw back to a temperature to meet the physical requirements of the tool, and allow it to cool in air.

It was not very long ago that the de-

sirability of drawing hardened high speed steel to a temperature of 1,100 deg. Fah. was pointed out, and it was indeed encouraging to learn that comparatively few treaters of high speed steel have failed to make use of this fact. Many steel treaters at first contended that the steel would be soft after drawing to this temperature and it is only recently that the old prejudice has been eliminated, after numerous tests have demonstrated the value of the new methods.

It might be stated that high speed steel should be delivered only in the annealed condition, because annealing relieves the internal strains inevitable in the manufacture and puts it in vastly improved physical condition. The manufacturer's inspection after annealing also discloses defects not visible in the unannealed state. The only true test for a brand of high speed steel is the service that it gives by continued performance under actual shop conditions. The average buyer of high speed steel is not justified in conducting a test, but can well continue to purchase his requirements of high speed steel from a reputable manufacturer that is nationally known. The manufacturer of high speed steel is always willing to cooperate with the trade in the conducting of a test and is much interested in the information received from a well conducted test approaching actual working conditions in the plant in which the test is made. The test should be conducted along lines laid down by the customer who may devise a test that would give the best basis for conclusions as to how the particular brands of high speed steel would perform under actual shop conditions.

The value of the file test depends upon the quality of the file and the intelligence and experience of the person using it. The file test is not reliable except in the hands of an experienced operator. The manufacturer of small tools made of high speed steel sometimes carries the file test to extremes. Almost every steel treater knows of numerous instances where a lathe tool which could be touched with a file has shown wonderful results as to cutting efficiency. The terms of warranty almost universally adopted, with slight variations, are as follows: "We will replace or allow credit for any steel which, if properly selected and used, shall prove defective, but we will not allow claims for labor or damage." There is no stronger or more equitable form of guarantee in any line of business. The manufacturer should be given the opportunity to have one of his experienced service men inspect and examine material claimed to be defective at his plant, in order that he may have the opportunity to determine the heat number from which the steel was rolled, its analysis, and other valuable data concerning its working through the mill. It is only by carefully following customers' complaints that the manufacturer is able to correct faults and improve his product. The maintaining of a competent corps of experienced service men helps the manufacturer as nothing else could in maintaining and constantly improving the quality of his product.

The practice of buying high speed steel by brand names is justifiable. The guarantee behind high speed steel is the standing and reputation of the manufacturer, who should maintain in his employ metallurgists and experienced service men who will be ready at any time to heat, treat and demonstrate to the buyer's satisfaction that the product furnished will meet any reasonable requirement. No steel treater can question the fact that the results obtained from heat treating depend upon the operator, and the results obtained depend largely upon his individual experience and skill to the end that a nearer approach to perfection may be obtained.

The Car Axle

Its Early History and Development

The early history of the car axle is not very well known and we have only occasional glimpses of its career prior to the formal organization of the Master Car Builders' Association in 1867. The first material used was wrought iron and that continued to be the standard well down through the seventies and early eighties of the last century, though steel had been used for many years is small or experimental quantities before its final and permanent use. And, during the transition period from wrought iron to steel there were many experiments in the composition of the latter.

The first steel axles to be used on the Pennsylvania R. R. were a small lot put under passenger cars in 1861. This continued up to 1868, most of those used having been imported from Naylor & Co., in England.

Based on experience with these axles the report of the superintendent of motive power of the Pennsylvania R. R. for 1866 contained this statement:

"We have received during the year 600 steel axles for passenger cars, and 1,307 freight axles, which we have been gradually putting in service since July last. Our experience in their use is too limited to warrant an expression of opinion as to their durability or safety as compared with the best iron axles. We are of the opinion, however, that they will prove much superior to iron axles in every respect."

This was corroborated in the report for 1867 as follows:

"Steel axles are now being used exclusively under all passenger, baggage and express cars, and very gradually under freight cars. Our experience thus far has proved them to be safer and much more durable than the best iron axles."

The Pennsylvania, therefore, was the first to adopt steel for passenger car axles and, in 1868, steel was used almost exclusively for that service and a few may have been used under freight cars. Their high price seems to have been the principal reason for not using more of them. But the introduction of steel went on steadily and rapidly and the last record obtainable of the purchase of iron axles by this road was in 1890 when there is a record of 100 iron axles having been accepted by the test department as against 35,800 steel axles accepted in the same time. In the previous year (1889) there were 300 iron and 43,860 steel axles accepted. So from 1890 nothing but steel was used for new axles on the Pensylvania.

Meanwhile in the early seventies a battle royal had been waged at the conventions of the Master Car Builders' Association over axle dimensions. The probable reason for this discussion lay in the lack of scientific training among the members of the association. As a member naively remarked at the 1872 convention: "In 1858 I used to have broken axles, and in thinking the matter over, had made up my mind that something was wrong."

The first record of the steel for new axles was used on the Pennsylvania.

The material, however, did not have clear and easy sailing into the port of adoption on other roads. Iron had been used for too long a time not to have created a prejudice in its favor especially in the matter of easy lubrication.

The opinion was very widely held that wrought iron journals were more easily lubricated than were those of steel. As one master mechanic expressed it, "Wrought iron is fibrous and the rolling of the journal under the brass smooths these fibers down like the nap of a silk hat." So there were all manner of rea-

sons more or less fantastic for this supposed superiority of the wrought iron axle.

The matter was discussed in a committee report in 1894 to this effect:

"The opinions of roads with regard to the comparative freedom from heating of iron and steel axles, seem to be about equally divided, and about all that can be said is that steel axles are freer from flaws and seams in journals than iron, and for that reason heat less from those causes. But, on the other hand, the grain of steel axles being much closer than in iron, there is less opportunity for the oil to be held in the minute spaces between the molecules of the metal, and, as a consequence, it is somewhat more difficult to lubricate steel journals, if they are loaded anywhere to their full capacity."

The probability is that any apparent differences that may have appeared were, for the most part imaginary. However that may be, the steel axle has entirely supplanted the older iron axle and it is doubtful if it will ever come back to its own again.

The matter of axles coming before the association was in 1869 when there was a long discussion, followed by the adoption of a resolution that "an axle for heavy passenger and sleeping cars should be at least 4½ in. in the wheel seat, and 3¾ in. in the center, the journals to be 3¼ in. by 7 in. long and of the best hammered iron."

This was an expression of opinion and not the formal adoption of a standard. Then the matter was dropped for two years to be brought up at the 1872 convention where a verbal report was made by a committee and there were tentative recommendations of a form of axle somewhat resembling the present shapes, but of much smaller dimensions. At first the suggestions were merely towards a uniformity of axles and oil boxes but before the meeting was over, they were talking about standards; the first man recorded as having used the term being Mr. M. C. Andrews of the New York & New Haven Railroad, and the size of journals recommended was 3¼ in. in diameter and 5½ in. or 6 in. long. This discussion closed with the appointment of a committee to report on car axles, oil boxes, journal bearings and center plates at the next meeting. This was in 1872.

The next year the committee made a report and recommended for adoption as a standard an axle 4½ in. in diameter at the wheel seat, and with a journal 3½ in. in diameter and 7 in. long. Mr. Adams of the committee presented a minority report suggesting a larger diameter of journal but giving no measurement. The matter was considered of such importance that discusion was postponed for 24 hours, when Mr. Adams came out with a definite recommendation to adopt 4 in. for the journal diameter. Then the discussion was on. The representative of the Pennsylvania argued for a smaller journal; he knew that 3½ in. was big enough because it and even smaller axles were running satisfactorily, and that such a big journal as 4 in. would not be used. Mr. Leander Gary of the New York Central was a prominent member in those days and his argument was the essence of good sense. He said: "I hope the gentlemen will not adopt anything because they think the Pennsylvania road or the Erie road or the New York Central road or any other railroad will adopt it, but will recommend something that will be right, if it is never adopted." The discussion occupied nearly the whole of the second day's proceedings and was continued on the third. For hours the discussion waged, the advocates for a small journal led by Mr. Van Houten of the Pennsylvania and those for the large by Mr. Gary of the New York Central. Finally after ballots for choice of dimensions one was taken on the recommendation of the committee for a 3½ in. by 7 in. journal. This was lost by a vote of 29 to 38. Then came the final vote on the 3¾ in. by 7 in. recommendation which was adopted unanimously, and the first standard of the Master Car Builders' Association was born.

It is interesting to note that in this whole discussion there was not one word about fiber stresses on the axle. It is doubtful if there was a man there that ever thought of it or of elastic limits and such like things. It was a discussion of purely practical men who were guessing at results and who fortunately guessed well. But it was a long time before the standard came to be accepted. In 1876 it was suggested to rescind the vote of 1873, and as late as 1878, there were a great variety of axles in use on many of the roads of the country; the Canada Southern alone reporting the possession of 18 classes.

In all of this there was nothing about specifications and tests of materials, nothing about stresses and the action under load. It was merely a matter of getting an axle big enough not to break, and one that would run cool in the journals. Hot boxes had been the bug-a-boo of the advocates of the small boxes and it took much argument to convince them that the higher peripheral speed of the larger journal could be made to run cool.

It must be borne in mind that at the time of the adoption of the first standard axle, the capacity of freight cars throughout the country was ten tons, without an allowable percentage of overload; that the weight of the empty car was the same and that there was no intention or expectation of increasing that capacity. The standard was adopted by the individual vote of the members present regardless of the number of cars under their jurisdiction, so that it is small wonder that there was a minority, opposing the increase in the general practice as to the size of axles when the discussion was filled with records of axles worn to all diameters down to 2 in. that had done their work without failure.

There were no tests and no specifications for axles proposed for purchase or inspection, and it was tacitly assumed that they would be of wrought iron. Indeed it was not until 1896 that the matter came up.

Meanwhile in 1886 a specification was drawn up by Mr. Theo. N. Ely, superintendent of motive power of the Pennsylvania R. R. for iron and steel axles which latter had, as we have seen, then become the standard axle material of the road. And these specifications may be regarded as the root from which later specifications were developed. They were as follows:

Specifications for Axles.

For each 100 axles ordered, 101 must be furnished, from which one will be taken at random, and subjected to tests prescribed for such axles. If the axle stands the prescribed test, the 100 axles will be carefully inspected and those only will be accepted which are made and finished in workmanlike manner and which are free from cracks or unwelded seams.

Locomotive tender and car axles to have journal swaged, and all axles to be centered with 60 degree centres.

Passenger Car and Passenger Locomotive and Tender Truck Axles.

Axles must be made of steel and be rough turned throughout.

Two test pieces will be cut from an axle, and the test sections of ⅝ inch diameter by 2 in. long may fall at any part of the axle, provided, that the centre line of the test section is one inch from the centre line of the axle. Such test pieces should have a tensile strength of 80,000 lbs. per square inch and an elongation of 20 per cent. Axles will not be accepted if the tensile strength is less than 75,000 lbs., nor the elongation below 15 per cent., nor if the fractures are irregular.

Freight Car and Freight Locomotive and Tender Truck Axles.

Steel.—Steel axles for freight cars, and freight locomotive, and tender trucks, will be subjected to the following test, which they must stand without fracture:

Axles 4 inches diameter at centre—Five (5) blows at 20 feet of a 1640 lbs. weight, striking midway between supports 3 feet apart; axle to be turned over after each blow.

Axles 4⅜ inches diameter at centre—Five (5) blows at 25 feet of a 1640 lbs. weight, striking midway between supports

3 feet apart; axle to be turned over after each blow.

Iron.—Iron axles for freight cars, and freight locomotives, and tender trucks, are to be hammered; new muck bar must be used, which must be thoroughly reworked at least once before piling for the axle; it must be tough, fibrous, uniform and free from scrap. If reworked by rolling the slabs must not be greater than ¾ inch thick when piled for the axle; if reworked by hammering, the power of the hammer must be sufficient to work the pile of its centre to the satisfaction of the P. R. R. Inspector. Such axles will be subjected to the following test, which they must stand without fracture:

Axles 4 inches diameter at centre—Three (3) blows at 10 feet and two (2) blows at 15 feet of a 1640 lbs. weight, striking midway between supports 3 feet apart; axle to be turned over after each blow.

Axles 4⅜ inches diameter at centre—Three (3) blows at 12 feet and two (2) blows at 18 feet of a 1640 lbs. weight, striking midway between supports 3 feet apart; axle to be turned over after each blow.

It will be seen that these specifications called for passenger car, locomotive and tender truck axles of steel, rough turned throughout, and subject only to tensile test, the requirements being a tensile strength of not less than 75,000 pounds per square inch (80,000 desired) and an elongation of not less than 15% in two inches (20% desired). For freight car, freight locomotive and tender truck axles, steel or iron, subject only to drop test.

It was not until 1896 that the axle question was brought before the Master Car Builders' Association in a scientific manner. In that year a committee headed by Mr. E. D. Nelson and having George Gibbs and William Forsyth as members presented a report containing a thoroughly scientific analysis of the whole axle question. It took up the matter of stresses and strains and concluded with a set of specifications for both steel and iron axles. Here we find the chemical composition of steel axles as well as their physical properties in the tests which both types must meet.

That the work of this committee was exceedingly well done is shown by the test of time. Take the delicate matter of chemical composition for example. Later specifications have merely given more latitude. If we compare the original composition as given in 1896 with that last issued in 1916 we find that carbon placed first at .40 per cent is given a range of from .38 to .52 per cent. Manganese had an upper limit of .50 per cent. and now has a range of from .40 to .60 per cent. Phosphorus stands as placed at .05 per cent and sulphur's upper limit has been raised from 04 to .05 per cent. So that axles made in accordance with the specifications set forth by the Nelson committee in 1896 would meet every requirement of today.

The dimensions of the axle have, of course, changed with the growth of car capacities. As we have already seen, the first standard axle with a 3¾ in. by 7 in. journal was designed for cars of 10 tons capacity without expectation of an increase. But before the end of the decade, that is, 1880, cars of larger capacity had come into service and the passage through capacities of 30,000 lbs.., 40,000 lbs. to 60,000 lbs. was very rapid.

It was found that the original standard was of ample strength to carry cars of 40,000 lbs. and a number of car builders contended, when the subject of a larger axle was brought up for discussion, that it was of ample strength for cars of 60,000 lbs. capacity. This may be considered the last of the practical man's entrance into the discussion for the determination of axle dimensions. He was defeated and in 1879 the association adopted an axle with journals 4¼ in. in diameter and 8 in. long for cars of 60,000 lbs. capacity. This held for 15 years until the standard for 80,000 lbs. with 5 in. by 9 in. journals was proposed by the Nelson committee in 1896. Since then two larger sizes have been made standard having journals 5½ in. by 10 in. and 6 in. by 11 in., respectively, for cars of 100,000 lbs. and 140,000 lbs. with an allowable 10 per cent overload.

These later designs are merely enlarged replicas of the original design, and if their contours are compared one cannot fail to be struck by the similiarity that persists throughout the whole range. And with this before us we must give great credit to those practical men in 1873 headed by Mr. Leander Gary who promulgated and secured the adoption of the first Master Car Builders' Association standard axle.

Standardization of Railroad Equipment.

In an opinion expressed to a Congressional committee on the above subject, Alba B. Johnson, president of the Railway Business Association, stated that in so far as standardization is desirable for the sake of practical stability and convenience of repairs, the railroads themselves, with the cooperation of the manufacturers, have in the natural course of business adopted and employed it. A standard specification in vogue on American railways is not the edict of a potentate or a board of potentates. It comes up from below. It must make its way into general approval before it can have the force of a regulation which the minority will observe. So far as the manufacturer goes, the matter of applicability, of usability, which is the same thing as interchangeability, is out of his hands without action of government. For several decades the Master Car Builders' Association and the Railway Master Mechanics' Association (locomotive), scientific institutes of railway officers, have annually added to the appliances whose dimensions and requirements for performance are "specified." These the American Railway Association, as it existed prior to government control, recommended to all the roads. Generally, they were put into effect as soon as announced. The need for standardization of locomotives is almost wholly imaginary. A locomotive rarely leaves the road owing it or even the division for which it was built; hence in time of peace and almost entirely in time of war all locomotive repairs are made at home. As to cars, interchangeability has been made universal in the United States.

Railroad Rolling Stock in France.

According to a report made by the Minister of Public Works, the rolling stock available for operation on January 1, 1919, comprised 14,574 locomotives, 368,683 freight cars, and 43,956 baggage and passenger cars, as compared with 13,800 locomotives, 376,000 freight cars, and 49,320 baggage and passenger cars on August 1, 1914. On the latter date there were 1,720 locomotives, 14,840 freight cars and 4,474 baggage and passenger cars out of repair or otherwise temporarily non-serviceable. The amount of such rolling stock on January 1, 1919, included 2,854 locomotive, 38,520 freight and 7,817 passenger and maggage cars. Deducting the non-serviceable there was on January 1, 1919, a net total of 11,720 engines, 330,163 freight cars, and 36,139 passenger cars ready for service, as against 12,080 engines, 361,160 freight, and 44,846 baggage and passenger cars on August 1, 1914, at the outbreak of the war.

New Electric Locomotives.

Prominent railway officials and engineers of the Chicago, Milwaukee & St. Paul system witnessed an exhibition of the new type of electric locomotives at the works of the General Electric Company at Erie, Pa., on November 8. The locomotives are of the bi-polar gearless type 3,000 volts direct current, the motor armatures being mounted directly on the driving axles, thus eliminating all power-transmitting devices, and giving a reduced low-cost maintenance. There are five of these new locomotives, each weighing 265 tons, with 229 tons on the drivers. They have 14 axles, and are capable of obtaining a speed of 65 miles an hour. They are being placed in service on the new Cascade electrification of the road known as the Othello-Seattle-Tacoma electric zone.

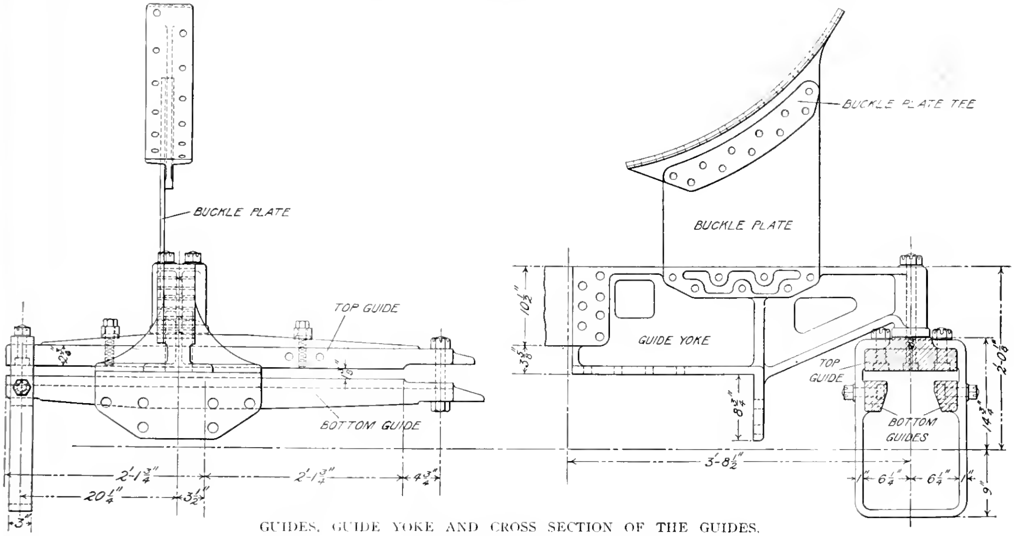
Details of Parts of the Pacific Type Locomotive as Shown In Our New Chart, No. 12

1. Crosshead, Guides, Piston and Piston Rod.

As stated in an announcement in regard to our new chart of a Pacific Locomotive, we begin the series of articles with a detailed description of the main reciprocating parts of the locomotive, the parts from which the locomotive receives its motion. As is well known, there are a variety of forms in which these parts are in service, and necessarily so, because the requirements of the service of the different types of locomotives are variable, from the lightest type of narrow gauge locomotive, and lighter types of switchers, to the heavier types of Mallets and other high-powered locomotives. It will be observed in the accompanying description that there is a degree of lightness in the parts which is largely the result of a marked improvement in the quality of steel and other metals. This is the result of long and successful experiments, and from recent developments it may be safely said that the end is not yet.

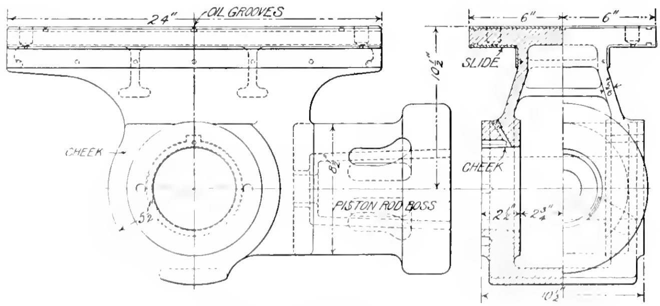
In selecting the Pacific type of locomotive, it may be safely stated that it presents in a marked degree a type of the most approved development of the modern high-powered locomotive, and a close study of the parts by the seeker after information cannot fail to add greatly to the complete mastery of details so essential to those engaged in the mechanical departments of railways.

Coming to the subjects immediately before us it may be repeated that the details of parts which we are describing are mainly those of the Class K 4 S of the Pennsylvania railroad, and many of the essential details of that type of engine have been used in the chart without any change whatever. Among these are the four pieces forming the subject of this article.



GUIDES, GUIDE YOKE AND CROSS SECTION OF THE GUIDES.

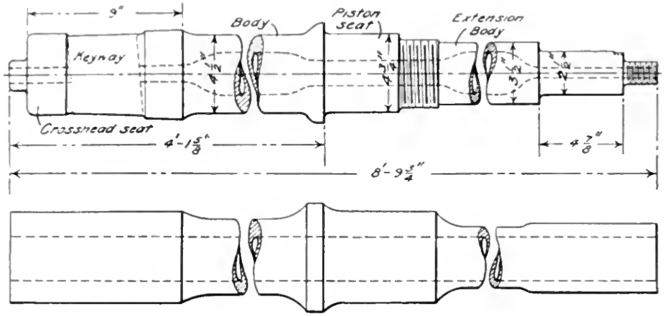
The guides are peculiar to Pennsylvania practice and are a modification of the box guide used so extensively on that road. As the engine runs forward for most of the time, it is evident that the top wearing face of the crosshead and the bottom bearing face of the guides are subjected to the greatest wear. For that reason it is desirable that these bearing surfaces should be made as large as possible and this has been attained in both the box guide and the one illustrated herewith. The elevation of the guide yoke and cross section of the guides shows how this is accomplished. There are three guides in all, one at the top and two at the bottom. The upper guide has a full bearing surface across its whole width which extends to the outer edges of the two lower guides and is 12 ins. wide. The lower guides have a width of 3¼ ins. each. This top guide also serves as the main support for the two lower ones. Both are carried at the cylinder end by the usual brackets cast to the back cylinder head. The upper guide is supported not far from the center of its length by the guide yoke to a heavy boss of which it is bolted by two 1¼ ins. bolts having cylindrical heads countersunk below the bearing surface.



DETAILS OF CROSSHEAD.

These are spaced 3½ ins. from center to center, and with the two bolts through the cylinder head bracket, serve to keep the guide in line.

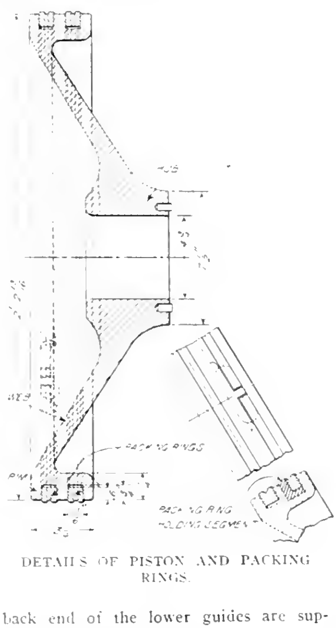
This upper guide is very heavy. The main body is 2½ ins. thick to the top of which is added a stiffening rib 5½ ins. wide rising to a thickness of 1⅝ ins. at the



EXTENSION TYPE PISTON ROD.

point of attachment to the guide yoke.

The two lower guides are 3¼ ins. wide and are held by the brackets on the back cylinder head at one end and a guide safety strap made of 3 ins. by 1 ins. steel at the back. As will be seen from the engraving, this strap and, with it, the



DETAILS OF PISTON AND PACKING RINGS.

back end of the lower guides are supported by the upper guide.

The material used for the guides is either steel forgings or castings.

The method of lining the guides with the cylinder center is that used since the memory of man runs not to the contrary. That is, by liners or shims placed at the point of support. Of course, in this case, the upper guide must be lined first and this is done by liners at the cylinder head bracket and beneath the guide yoke bearing against the guide. The lower guides are lined at the ends as with the old-time construction.

The guide yoke is a steel casting bolted to the outside of the frame and with a buckle plate attaching it to the barrel of the boiler.

The crosshead is a very light steel casting. All superfluous metal has been cut away and it consists of a boss into which the piston rod is keyed, two check pieces for holding the crosshead or wristpin and two lips to act as bearing surfaces against the guides. It is 10½ ins. from the top bearing surface to the center of the wristpin which gives a clearance for the connecting rod when the crankpin is on the upper quarter. The bearing surfaces are 24 ins. long by 12 ins. wide, so that there is 2 sq. ft. of bearing surface for the upward thrust of the crosshead which drops to 1 1/12 sq. ft. or 156 sq. ins. for the lower surface which carries the weight of the crosshead when the engine is drifting and to which the thrust of the connecting rod is added when the engine is using steam and running backwards.

The bearing surfaces are lined with ⅛ ins. of dandelion metal which is held by tinning and dovetailed grooves. Its own surface is also scored with oil grooves.

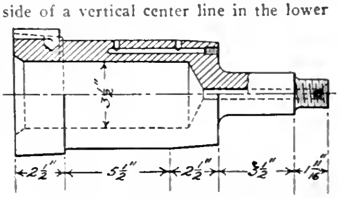
Dandelion metal is a white bearing metal composed of 72 per cent lead, 10 per cent tin and 18 per cent antimony. The wristpin is hollow and is turned to fit a taper bore in the two cheeks of the crosshead, where the tapered surfaces are in line with each other. The pin, of course, is turned to a cylindrical form between the cheeks to take the connecting rod brass, where it has a diameter and length of 5½ ins. It is put in place from the inner face of the crosshead and held by a nut on the outside. The piston rod is of the extension type and runs from the crosshead through the stuffing box and piston to the end of the extension. It is of steel, first forged to the dimensions shown and a 2½ ins. hole is bored through it from end to end. The enlarged portions are then forged down to proper size for turning. This leaves a ½ in. hole from end to end, except where it has not been forged down where it is 2½ ins. in diameter, as shown in the drawing.

The back end of the rod is fitted to the crosshead on a taper of one in thirty-two, where it has a bearing at the ends only, the center being cut away as shown in the engraving. It is held to the crosshead by the usual key. These bearings are 3 2/16 ins. long at each end with a total distance of 9 ins. over all. The body of the rod is 4½ ins. in diameter.

The piston is shrunk upon the rod with a shrinkage allowance of .01 ins. on a nominal seat diameter of 4¾ ins. or a ratio of 1 to 475.

The piston is set up against a shoulder on the rod and is held by a 4-ins. nut on the extension portion. This extension portion is 3½ ins. in diameter.

The piston is of the dished type and is a steel casting with a web tapering from ½ ins. to 1 ins. in thickness. The packing rings are plain spring rings with an L-shaped segment let into the groove at the joint to prevent the ring from turning. The joints of the two rings are staggered and set 120 deg. apart or 60 deg. on each side of a vertical center line in the lower



DETAILS OF WRIST PIN.

half of the circle. The rings have a width of 13/16 ins. and a depth of 11/16 ins. plus the difference in the radii of the piston and the inside of the cylinder. The grooves in the piston are cut to the width of the packing so as to allow ease of movement laterally and are ¾ ins. deep.

In fitting the piston it is rough turned to a diameter ⅜ ins. larger than that of the cylinder, and then turned to fit. The rings are turned ⅜ ins. larger than the bore of the cylinder and are then sprung into place, and each is fitted with a semicircular circumferential groove 3/16 ins. wide and 3/32 ins. deep to serve as a water packing. The rings also follow the usual practice and are of cast iron.

These three pieces, crosshead, piston and piston rod, with their necessary complement of keys, pins and nuts, form the true reciprocating parts and have the following finished weights:

Crosshead, 480 lbs.; piston and piston rod, 820 lbs.; total, 1,000 lbs.

These weights, with the weight of the connecting rod, are used for the determination of the counterbalance which will be discussed in a later article.

Baldwin & Whitney's Locomotive Engine for Passenger or Freight Service—An Early Baldwin Locomotive

By J. Snowden Bell

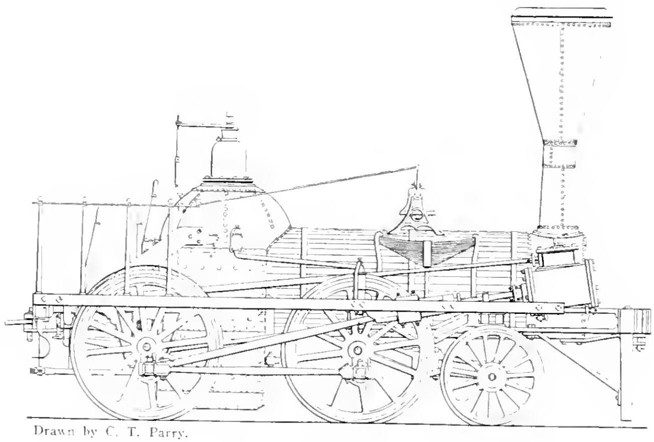
The accompanying illustration, which is reproduced on a smaller scale, from a drawing made by Mr. C. T. Parry, who subsequently became a member of the firm of M. Baird & Co., one of the predecessors of the present Baldwin Locomotive Works corporation, shows a wheel arrangement which was designed by M. W. Baldwin, with the object of rendering a large proportion of the weight available for adhesion, and, at the same time, affording adequate facilities for traversing curves. The writer, while familiar with the essential structural features of this design, has never seen a drawing of it in any technical treatise or journal, and believes that its showing will be as novel to locomotive men of the present day as it was to him, on recently seeing one.

The so-called "flexible beam truck," as invented and patented by Mr. Baldwin, in 1842, provided for journalling the two front axles of a six-wheel locomotive, all the wheels of which were drivers, in two parallel beams, each of which was centrally pivoted to one of the side members of the main frame, thereby permitting independent lateral movement, in opposite directions, of the two axles in passing curves. It was first applied in engines of this type, and later, similarly applied, to a considerable extent, in eight coupled engines, some of which were built for the Pennsylvania R.R. as late as 1857, and for other roads, as late as 1866. The advent of the four-wheel leading truck, invented by John B. Jervis, and first applied by him on the Mohawk & Hudson Ry. in 1832, impressed the railroad men of the United States so favorably that within a few years thereafter it was generally adopted, and soon became, and has since remained, standard. The origin and development of the design illustrated will be understood by reference to the following excerpt from the Illustrated Catalogue of the Baldwin Locomotive Works, 1874, page 23:

"But the flexible beam truck also enabled Mr. Baldwin to meet the demand for an engine with four drivers connected. Other builders were making engines with four drivers and a four-wheeled truck of the present American standard type. To compete with this design, Mr. Baldwin modified his six-wheels-connected engine by connecting only two out of the three pairs of wheels as drivers, making the forward wheels of smaller diameter as leading wheels, but combining them with the front drivers in a flexible-beam truck. The first engine on this plan was sent to the Erie & Kalamazoo Railroad, in October, 1843, and gave great satisfaction. The superintendent of the road was enthusiastic in its praise, and wrote to Mr. Baldwin that he doubted 'if anything could be got up which would answer the business of the road so well.' One was also sent to the Utica & Schenectady Railroad a few weeks later, of which the superintendent remarked that 'it worked beautifully, and there were not wagons enough to give it a full load.' In this plan the leading wheels were usually made thirty-six and the drivers fifty-four inches in diameter.

"This machine, of course, came in competition with the eight-wheeled engine, having four drivers, and Mr. Baldwin claimed for his plan a decided superiority. In each case about two thirds of the total weight was carried on the four drivers, and Mr. Baldwin maintained that his engine, having only six instead of eight wheels, was simpler and more effective."

The first engine of the type illustrated, which was, as stated in the Catalogue, built in October, 1843, was classed as 12 tons. The cylinder dimensions of this particular engine have not been found on record, but later ones of the same type had cylinders 13 x 16 inches and 54-inch driving wheels. Four of these were built in 1843 and 1844. The only other class of this type was of 15 tons' weight; cylinders, 13½ x 18; driving wheels, 60 inches. Six of these were built, the last in June, 1845. In June, 1846, one of the 12-ton class, with cylinders 13 x 16, and 54-inch driving wheels, was built for the Philadelphia, Germantown & Norristown R.R., now a part of the Reading System, but was rebuilt into a six-wheels-connected engine, with 40-inch driving wheels. This type was not thereafter continued in practice of Baldwin Works.



Drawn by C. T. Parry.

BALDWIN & WHITNEY'S LOCOMOTIVE ENGINE FOR PASSENGER AND FREIGHT SERVICE.

The design was not without merit at its date, but obviously could not successfully compete with those in which a four-wheeled leading truck was applied. It will be noticed that the engines bear the earmarks of the early Baldwin practice; the hemispherical or "Bury" dome, inclined cylinders, outside frame bars, drop-hook valve motion, and pump-barrel cross-head guide.

Rolled Steel Wheels.

From tests recently made it appears that rolled steel wheels when worn down to or below the limit of wear, even though the flanges are worn sharp are not weakened in the flange, but only in the tread. In this condition the flange is considerably stronger than that of cast iron wheels.

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Please give prompt notice when your paper fails to reach you regularly.

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Delayed Publication

The delay in the issuance of the October and subsequent numbers of RAILWAY AND LOCOMOTIVE ENGINEERING was briefly explained in the Emergency Bulletin to our readers and advertisers alike. We are now making every effort to bring the issuance of the delayed numbers back as closely as possible to what should have been the regular scheduled date for their appearance, and are confident of doing so shortly. The strike, which tied us up for seven weeks, has driven nearly one-third of the publications affected from New York City. We are going to stay where we are, or hope to. The words of encouragement that have come to us from every section of the country are very gratifying indeed. All we asked was fair play and we are going to have it, if it takes seven weeks, or seven years. If we have been unable to issue our periodical in the first week of each month as hitherto, the fault is not our own. We now know what it means to enjoy the forbearance and hearty support of our readers and advertisers in such an emergency. That has been our compensation for the trouble. We have been so well paid, we don't know how to thank them.

Staybolt Deflection

The article on staybolt deflection, which appears in another column, sets forth some interesting and astonishing data gathered in an entirely new field of research. We have known for many years that staybolts were subjected to deflection in a locomotive form boiler, but as to the character and amount of this deflection we had no information whatever. There have been many surmises and many calculations made as to the amount of the deflection, and many surmises as to the distribution of the variations of expansion of the two sheets of the firebox. But, so far as we are aware, this is the first attempt that has ever been made to measure the amount and locate the character and distribution of the deflections and the corresponding stresses caused thereby.

There has been the assumption that the deflection was greatest at the ends of the firebox, because it was at the ends that the breaking zones of staybolts were located. It was also assumed that the inner ends of the bolts at the back end of the firebox were bent to the rear, while those at the front were correspondingly bent to the front. From this it was argued that midway between these two points there was a neutral axis where the bolts were not bent at all, and this was borne out by the fact that along this supposedly neutral axis the smallest number of breakages occurs.

Then it was assumed and even publicly stated at a meeting of engineers within a week of the appearance of this article that the temperature stresses developed in a locomotive firebox were negligible. The supposition being that, after steam had been raised and the boiler had settled down to its work of steam production, the two sheets of the firebox returned to their original position of parallelism and adjustment and that the staybolts again stood at right angles to each sheet and were subjected only to the tensile stress put upon them by the steam pressure acting on the stayed area allotted to each one of them to support. It was taken for granted that all of the deflection occurred during the period of raising steam. Why this assumption should have been made is difficult to tell, except that everyone thought, not excepting, we believe, the author of the article under consideration, that the staybolts were in their normal position while the boiler was at work, and if this were true, then the only time when deflection could have occurred was during the steam raising period. So the whole thing seemed to have been demonstrated to the quieting satisfaction of all concerned.

For this bending at all was merely a sop thrown to Cerebus to account for the peculiarity of staybolt fractures, which showed unmistakably that the initial fracture and its progression through the bolt was caused by the bending of the same. So bending had to be accounted for, and it was most easy to lay it to the probable inequalities of temperature existing while steam was being raised; but no one imagined it to be a continuous performance.

But now it appears, from the investigations of Mr. Fowler, that all of these assumptions are more or less erroneous. The only one of the lot that has a foundation in fact is that the inner end of the staybolts at the back end of the boiler are bent to the rear, while those at the front are bent in the opposite direction. Beyond that every supposition seems to be wrong. The bolts are bent in the directions named, to be sure; but they are also bent upward by an amount dependent upon their position vertically in the firebox, and when once bent they stay bent and bending. And this last is the one big fact which has been brought out and which is of the most importance that we should know. The tensile stress to which the staybolts are subjected is insignificant in comparison with that imposed by the bending stresses. That staybolts never occupy their normal position at right angles to the surface of the sheet while the boiler is under steam, explains many a staybolt breakage. Of course, they should break if their ends are in constant motion relatively to each other, for it puts them in what is practically a vibrating or bending test machine that holds them out of alignment and keeps them moving all the time. It appears from the article that out of the hundreds of readings that were taken no two consecutive ones among them were the same. And, also, that it was only when the boiler was cold or had been allowed to stand for hours that the staybolt came back to its normal position at right angles to the two sheets.

This constant movement strikes a blow at the hypothesis of a neutral axis at the longitudinal center line of the boiler. With both ends of the inner sheet in constant motion relatively to the outer, of course there can be no fixed neutral axis. If there is one at all, it must be an instantaneous one, and this conclusion is sustained by the records, which show that here, too, the staybolts are being constantly bent to and fro, though to a lesser amount than those at the ends. And this explains the reason for the smaller number of breakages at the center of the boiler, as well as the fact that they do break at all. They are bent, but not so much.

Now, if staybolts are bent in such a fashion as this, what happens to the sheet? Here supposition led Mr. Fowler astray in his preliminary work. He as-

sumes that the two sheets remained parallel to each other at all times, and it was only when they did not, and threw his instrument so much out of line as to indicate movements that could not reasonbaly be supposed to take place, that he realized that the sheets were buckling and that his first readings were in error. Then came the discovery that not only were the staybolts bending to and fro, but also that the whole sheet was covered with a series of corrugations or humps whose crests seem to be at the point of staybolt attachment. And, also, that these waves are, like the bolts that cause them, in constant motion. And in this we may find an explanation for the cracking of the inner sheets that so frequently occurs at the staybolts.

Then comes the movements in the firebox caused by the expansion and contraction of the tubes, which tells of back tube-sheet movement as well.

It also appears that there is a difference in the behavior of the radially stayed and the Wootten firebox, but as to just what this amounts to cannot be stated definitely because of the difference in the instruments used for making the determinations on the two types of boilers. But that this difference is considerable and important there seems to be no doubt.

These investigations, preliminary as Mr. Fowler states that they are, certainly disclose many new and important features of boiler operation. And if they can be carried out to the full completion of the program that has been laid down, they should stand in the first rank among boiler investigations. It remains to see what would happen with a full installation of flexible staybolts in a Wootten boiler; what really happens to the sheets of the radially stayed, and then what differences will appear when the investigation is carried to the Belpaire and narrow ogee fireboxes. For they may result in the speaking of the decisive word as to the relative merits of the several types for locomotive work. Certainly research along these lines ought not to be brought to an end with these preliminary tests.

The October Safety Drive.

When the ghosts of ten thousand men, women and children appeared in grim statistics year after year when the list of dead were unrolled as the results of railroad accidents, who was it that should have exclaimed in the words of Macbeth: "Never shake thy gory locks at me, thou canst not say that I did it!" We do not know, but we suspect, that it was the commissions, Federal and State, who would not permit the railroads to charge sufficient rates to provide transportation at such prices as would allow something for safety. Public clamor called into being the workingmen's compensation act, and the railroad managers began saving something from their necessities to lessen the casualty list, robbing Peter to pay Paul. Hence the call for "safety first" grew into a chorus. The living gave vocal utterance to the call of the dead, and many of the brightest and best minds in the railroad world took council and thought blossomed into action. From October 18 to 31 was selected as a period of united effort to see what could be accomplished. The results so far as the eastern region is concerned is monumental. The casualties show a decrease of 48 per cent., in the face of an increase of an enlarged traffic calling into physical activity more than 10,000 employes in 101 railroads in the eastern region. Of these railroads 61 showed a clear record. Railroads, of course, vary in size, but it is noteworthy that among the larger railroads most all of the records are remarkable, the Wabash heading the list, with only one casualty, as against twenty-two in the same period last year.

The national drive closing in the end of October followed other successful sectional and local campaigns, but was on a larger scale than any previously attempted. In the first seven months of 1919, there were 1,389 less deaths from railroad accidents and 22,106 less injuries than in the first seven months of 1918. If these results can be accomplished by intermittent efforts, surely it is within the range of possibility to continue the efforts and expand the periods until the occasional two weeks of "safety first" stretch into fifty-two weeks each year.

Thinking Before Acting.

There is an old story to the effect that a man was once suing his neighbor for damages, and when his lawyer made his plea, he blubbered and wept most piteously all through it. "What are you crying about?" the lawyer asked. "I had no idea that I had suffered so," replied his client. This seems to express the situation of very many workmen. They had no idea that they had suffered so, or indeed suffered at all until they had been inoculated with the germs of discontent. It is an unfortunate characteristic of human nature that its inclination to believe the ill is greater than that to believe the good. Then the average man is apt to be swept off his feet by a glib talker who makes great promises of an immediate millennium, and will follow him to any lengths. The history of the country is full of examples of just such wanderings from sane and sober action. Under ordinary conditions such aberrations work no great harm, and the evil cures itself. But these are not ordinary conditions and times and the bad effects of idleness and decreased production are felt at once. We are suffering from an under production of the necessities of life, and the true interest of the country and of every individual in it lies in the speeding up of production to counteract the shortage in every line. Strikes merely make bad matters worse, and the trouble is that they are not organized by men who have the interest of the workingmen at heart, but their own selfish aggrandizement. The better and more intelligent class of workmen have no sympathy with the movement, because they know that their own position is secure and object to the leveling down process that results from radical action.

As matters stand now there is already much idleness and a prospect of much unemployment and consequent suffering if the present movement continues. There is such a thing as raising rates beyond what the traffic will bear, and when this is done there is no traffic.

It is a very easy thing to stand upon a soap box and decry the government and everything in the existing order of things, but quite a different task to reconstruct upon a foundation of hasty promises and half-baked ideas a structure that will have the necessary power of endurance.

So the workman, who is approached by an apostle of discontent, will do well to consider that apostle's preaching carefully before allowing himself to be swept off his feet by specious arguments. Let him ask first if the apostle knows what he is talking about. Is he telling the truth? Are the promises he makes possible of realization with human nature as it is? Are the conditions which he paints as of the true Utopia even desirable? Is it the part of a man and an upright member of society to participate in the proposed action? Can he do it and be true unto himself?

These are some of the questions that a man should ask himself. He should think for himself and not be led like a bear by the nose, and that is the great trouble. Most men do not think for themselves. If they did the day of radical revolutionists would be short, and that of the real reformer long and pleasant.

The Return of the Railroads.

Notice has been served on Congress by the Administration that the railroads will be returned to private ownership at the advent of the new year. This is sooner than we expected, but not sooner than they should be. As to the amount due the railroads, a country with 38 billions of debt need not scruple at making it the even 40. We presume that there are enough printing presses in Washington to issue a new set of bonds. If not, there are some here that have been standing idle for some weeks ready to get busy. There is no better collateral in the world than United States Government bonds.

Air Brake Department

Questions and Answers

Locomotive Air Brake Inspection.

(*Continued from page* 310, *Oct.*, 1919.)

959. Q.—How is the plug valve of the present type of cock held to its seat?

A.—By means of a port drilled through the large end of the cock, which permits pressure from the reservoir pipe to assist the spring to hold it to its seat.

960. Q.—What advantage is there in the use of a cut-out cock in the reservoir pipe instead of the brake pipe?

A.—The brakes may be applied from the second engine of a double header, without the necessity for first opening the brake valve cut-out cock.

961. Q.—Can the brakes be applied in service from the second engine?

A.—No, only in emergency.

962. Q.—Why not in service?

A.—Because the brake valve service port is closed when the double heading cock is closed.

963. Q.—Is this of any disadvantage, being unable to apply the brakes in service from the second engine?

A.—No, there would be no necessity for applying them except in cases of emergency, besides the brakes could not be applied by a service reduction and held applied while the lead engine was feeding main reservoir pressure into the brake pipe.

964. Q.—With the brake valve cut-out or double-heading cock located in the reservoir pipe, what is the object of the non-return check valve in the application cylinder branch pipe to the automatic brake valve?

A.—To prevent a back flow of air from the application cylinder to the automatic brake valve.

965. Q.—At what time might such a flow back occur?

A.—After the brake is applied in emergency and all of the air pressure exhausted from the brake pipe.

966. Q.—What might be the effect without the check valve at such a time?

A.—Application cylinder pressure might possibly unseat the brake valve rotary and release or partially release the brakes on the second engine at a time when they were needed.

967. Q.—How could all of the brake pipe pressure be exhausted by an emergency or quick action application?

A.—By following instructions to leave the brake valve in emergency position until the train has stopped or until the danger has passed, or through a bursted hose or an open conductor's valve.

968. Q.—In what other way can brake pipe pressure entirely exhaust?

A.—Universal valves and Passenger Control valves exhaust the brake pipe pressure to the atmosphere when they assume quick action or emergency position.

969. Q.—Should any repairs be made to a brake valve or feed valve while it is on the locomotive?

A.—No.

970. Q.—Why not?

A.—Because either one of these valves should be tested on a shop rack before being returned to service after repairs are completed.

971. Q.—Is it permissible to clean a brake valve without removing it from the locomotive?

A.—Yes, if all that is required is cleaning.

972. Q.—Is it permissible to clean a feed valve without removing it from the locomotive?

A.—No. Cleaning without a test might leave the valve in a worse condition than it was before the cleaning was attempted.

973. Q.—In what way?

A.—Removing any foreign matter from the feed valve, especially from the supply valve piston and the regulating valve seat, changes the previous relation of these parts to those they come in contact with.

974. Q.—As an example?

A.—When oil or dirt is removed from the supply valve piston or bushing, the piston may be too loose a fit in the bushing when replaced. Similarly, when the dirt is removed from the regulating valve and seat, it may start a leak.

975. Q.—What is the effect of too loose a supply valve piston?

A.—It prevents the operation of the feed valve on slight lowering of brake pipe pressure.

976. Q.—Why?

A.—Because the loose fitting piston will permit main reservoir pressure to pass it at the same rate that it may be escaping from the brake pipe, and if so, there will be no movement of the supply valve piston in supplying the leakage.

977. Q.—What is the effect of a leaky regulating valve or a leaky supply valve?

A.—If a bad leak, the brake pipe pressure on the lone engine will increase above the adjustment of the feed valve, and if a small leak, will have the same effect as a loose supply valve piston.

978. Q.—In what manner?

A.—The pressure that leaks from the main reservoir into the brake pipe, will have the same general effect as though it was leaking past the supply valve piston.

979. Q.—What is the most important fit in connection with the feed valve or reducing valve repair work?

A.—That of the supply valve piston in its bushing.

980. Q.—The effect of too neat a fit?

A.—Too wide a variation between the opening and closing of the feed valve.

981. Q.—How will this show on a test gage?

A.—By a variation or fluctuation of more than 2 lbs. in brake pipe pressure.

982. Q.—How will the amount of fluctuation vary?

A.—In proportion to the fit of the supply valve piston.

983. Q.—Can a piston be made to fit a worn bushing?

A.—No, this is one of the impossible things in air brake repair work.

984. Q.—How are these bushings kept true?

A.—By returning the valves to the manufacturers for repairs when the bushings are found to be worn.

985. Q.—Why cannot this work be done successfully in the average machine shop?

A.—Because it is necessary to grind these bushings to a perfect state, and if done on a lathe, it will only be a temporary job and the valve will fail to operate correctly after a short time in service.

986. Q.—What is the maximum opening through the feed valve to supply the brake pipe?

A.—About 1/10th of a square inch.

987. Q.—Is there any difference between 1/10th of a square inch and 1/10th of an inch square?

A.—Yes, the former is an area of the 1/10th part of a square inch, while the latter is a square 1/10th of an inch on each side.

988. Q.—What is the capacity of the feed valve in cubic feet of free air delivered to the brake pipe?

A.—It varies from about 30 to 125 cubic feet of free air per minute.

989. Q.—At what time does the maximum rate of delivery occur?

A.—With a high main reservoir pressure and an empty brake pipe.

990. Q.—And the minimum?

A.—When the brake pipe pressure is within about 3 lbs. of the adjustment of the feed valve.

991. Q.—What is the most important thing to be observed in connection with the regulating valve of the feed valve?

A.—That it is straight, of the correct length, and a fit in the bushing.

992. Q.—Why is the fit of the valve

in the bushing of any consequence when the regulating valve spring will return it to its seat after an operation?

A.—If loose, it tends to "roll" about and form an imperfect seat.

993. Q.—And the effect?

A.—The wings of the valve do not guide it to the same movement or seat at all times, so that at times the valve seats properly and at other times it does not.

994. Q.—And when it does not seat properly?

A.—It leaks, permitting brake pipe pressure to increase.

995. Q.—What is the usual effect of a loose regulating valve when the feed valve is tested on a test rack?

A.—The feed valve operates correctly for some time, then suddenly and without noticeable reason the reservoir and brake pipe pressures equalize.

996. Q.—How is the correct length of the valve determined?

A.—With a small straight edge that will enter the cavity into which the spring box is screwed.

(To be continued.)

Train Handling.

(Continued from page 311, Oct., 1919.)

1013. Q.—At what point do these leaks generally occur?

A.—Through the brake valve body gaskets.

1014. Q.—When the brake applies or "creeps on" with both brake valves in running position, what repairs are necessary?

A.—Brake pipe leakage to be stopped and the brake pipe feed valve to be repaired, provided that the brake has not been caused to apply by overcharging the brake system with the valve handle too long a time in release position.

1015. Q.—Will remedying either one of the defects stop the undesired application?

A.—Yes, but both disorders, if existing, should be remedied.

1016. Q.—Why will not moving the valve handle to release position prevent a recurrence of the brake applying with the handle in running position?

A.—Such movements aggravate the disorder by further overcharging the pressure chamber of the distributing valve.

1017. Q.—Why do movements of the independent brake valve fail to keep the brake released?

A.—The movement of the independent valve only affects the application portion of the distributing valve, while movements of the equalizing portion are causing the applications of the brake.

1018. Q.—What would be wrong if the brake persisted in "leaking on" with the lone engine, and there was no brake pipe leakage, and the brake would not apply if the valve handle was placed on lap position?

A.—The feed valve would of course be defective, and the leakage would be found in the feed valve pipe.

1019. Q.—Why does the feed valve pipe leakage not show with the brake valve handle on lap position?

A.—As explained in connection with governor troubles, the feed valve pipe is not in communication with the brake pipe when the valve handle is in lap position.

1020. Q.—What is the effect of a leaky rotary valve in the automatic brake valve?

A.—If in excess of the leakage from the brake pipe, the brake pipe and main reservoir pressures will equalize.

1021. Q.—Will this result in a release of the engine and tender brake?

A.—Not unless the modified type of distributing valve is used.

1022. Q.—What is the difference?

A.—In one case the release pipe is open to the atmosphere and in the other it is closed preventing the release of the brake.

1023. Q.—How is rotary valve leakage quickly shown?

A.—By closing the brake valve cut-out cock in the brake pipe, when leakage will quickly show on the air gage or lift the equalizing discharge valve.

1024. Q.—How is leakage from the main reservoir into the brake pipe through the brake valve detected, or the source located when the cut-out cock is in the reservoir pipe?

A.—By first placing the brake valve handle on lap position to note whether the feed valve is at fault. If pressure thereafter increases, the brake valve cut-out cock would be closed.

1025. Q.—What would be wrong if the pressure increased after closing the cut-out cock in the reservoir pipe?

A.—The cock itself would be leaking main reservoir pressure into the brake pipe.

1026. Q.—But if the pressure did not increase with the cock closed?

A.—It would indicate that the rotary valve of the brake valve was leaking.

1027. Q.—What could prevent the application of the independent brake?

A.—The reducing valve failing to open through a stuck supply valve piston.

1028. Q.—What could be wrong if nothing unusual was noticed in the operation of either one of the brakes, but some time after the compressor is shut down an attempt is made to apply the independent brake and it fails to apply?

A.—It indicates that the application cylinder and release pipes are wrongly connected.

1029. Q.—How would this prevent the application of the independent brake?

A.—The compressor not operating allowed the equalizing portion of the distributing valve to move to lap position.

1030. Q.—And the flow of air from the reducing valve pipe is?

A.—Through the application cylinder pipe, and being wrongly connected, to the exhaust cavity of the equalizing slide valve instead of into the application cylinder.

1031. Q.—Accidents have resulted from this, could it happen while the compressor was operating?

A.—Yes, with low steam pressure on the boiler.

1032. Q.—Could it occur with maximum air pressure in the main reservoir and brake pipe?

A.—Yes, if the brake was applied in service, the handle remaining on lap position, while the release was made with the independent valve.

1033. Q.—What sometimes causes a sharp exhaust from the distributing valve when the signal whistle is operated with the independent brake applied?

A.—A reduction in application cylinder pressure through the reducing valve failing to open promptly.

1034. Q.—Why does this seldom occur?

A.—Because the application portion of the distributing valve is seldom sensitive enough to move before the reducing valve can open and supply the reduction in signal pipe and application cylinder pipe pressure.

1035. Q.—How is the application cylinder and the signal system connected at this time?

A.—Through the independent brake valve being in application position.

1036. Q.—What else does this connection account for if the independent brake is fully applied and the automatic brake is applied with 8 or 10 lbs. reduction?

A.—For the drop in application cylinder pressure that results when the automatic valve is returned to lap position.

1037. Q.—To make it clear, the drop is due to what?

A.—Application cylinder pressure passing through the independent brake valve to the signal system.

1038. Q.—Doing what?

A.—Reducing application cylinder pressure, starting a blow at the distributing valve exhaust port, and possibly overcharging the signal system.

1039. Q.—What is wrong when nothing is found wrong with the operation of the equipment until after a heavy reduction in brake pipe pressure, when the brake valve equalizing piston lifts and continues to discharge brake pipe pressure to the atmosphere without causing any lowering of brake pipe pressure?

A.—The check valve of the quick action cap of the distributing valve is leaking.

1040. Q.—Permitting a flow of air from where to where?

A.—From the main reservoir through the brake cylinders into the brake pipe and out of the brake valve service exhaust port.

1041. Q.—Could the leak be through any other part than the check valve?

A.—Yes, through the cylinder cap gas-

ket if broken between the brake pipe and brake cylinder ports.

1042. Q.—Quick action cylinder cap alone?

A.—With either the plain or quick action cap.

1043. Q.—Would this defective gasket show any disorder at any other time?

A.—Yes, by a blow from the distributing valve exhaust port while the brake is released.

1044. Q.—Why does the defective check valve seat fail to show a blow when the brake is released?

A.—Because there is no air pressure in the brake cylinders at such times and even if there was the emergency slide valve would prevent the leakage into the brake pipe until after brake pipe pressure was lower than pressure chamber pressure.

1045. Q.—With the brake valve handle on lap position, equalizing reservoir pressure increases equal to that in the main reservoir, but brake pipe pressure does not increase even with the brake valve cut out cock closed?

A.—A leak into the equalizing reservoir from the main reservoir.

1046. Q.—How does this affect the application of the brake?

A.—It cannot be applied in service until after the pressure has been reduced below that in the brake pipe equalizing reservoir.

1047. Q.—Can this happen with the collapsible brake valve equalizing piston?

A.—No. With 2 lbs. difference in pressure equalizing reservoir pressure discharges into the brake pipe.

1048. Q.—With the brake valve in service position, the usual blow from the preliminary exhaust port, but the equalizing piston does not lift?

A.—A gasket broken between the brake pipe and equalizing reservoir, or the brake pipe service exhaust port stopped up.

1049. Q.—How could the brake pipe service exhaust port be stopped up?

A.—Through someone having plugged it on account of a broken pipe or hauling the engine dead in a train, and neglect to remove the plug or blind gasket.

(To be continued)

Car Brake Inspection.

(Continued from page 312 Oct., 1919)

932. Q.—Can the brake be applied in quick action after a full service brake application.

A.—No, after a high brake cylinder pressure is obtained the brake pipe pressure cannot be discharged into the brake cylinder in sufficient volume to operate the quick action piston, or the drop in pressure in the by-pass piston chamber necessary to operate the by-pass valve cannot be obtained.

933. Q.—Sometimes with the valve in release position the brake pipe and reservoirs charged and the brake cylinder empty, an occasional slight pop is heard from the safety valve, what causes this?

A.—A leaky triple valve slide valve leaking air pressure into the safety valve passage.

934. Q.—How can this slide valve leakage be distinguished from the failure of the graduating valve to close after a light brake pipe reduction and a movement of the triple valve slide valve to release position?

A.—By the volume of air pressure escaping at the safety valve, in one case the pop actions are very far apart and in the latter case the safety valve is compelled to pop away a volume that is in proportion to the capacity of the quick service port in the slide valve, and seat.

935. Q.—With the auxiliary reservoir charged to 110 lbs. and the supplementary empty, what pressure will the reservoirs equalize when the supplementary is cut in with brake pipe pressure maintained?

A.—At between 40 and 45 lbs. the charging ports from the brake pipe being open while the pressures are equalizing.

936. Q.—Why is it that air pressure is sometimes maintained in the brake cylinder while the brake pipe and reservoirs are empty?

A.—Because of a strong slide valve spring and moist lubricant of the slide valve seat of the triple valve, and because the brake pipe pressure was exhausted before the reservoirs were drained.

937. Q.—In what position is the triple valve after such bleeding?

A.—Between emergency and service lap position.

938. Q.—How was this position assumed?

A.—When the brake pipe was opened to the atmosphere the piston and slide valve traveled their full stroke compressing the graduating spring, and after the auxiliary and supplementary reservoir pressures were exhausted, the graduating spring returned the piston and slide valve toward service lap position, bottling up the light pressure remaining in the brake cylinder.

939. Q.—How does the high pressure first obtained in the brake cylinder escape?

A.—Through the auxiliary reservoir, while the valve is in emergency position as these volumes are then connected until the combined pressures reduce to a point where the graduating spring can move the triple valve piston and slide valve.

940. Q.—How would the brake cylinder pressure then escape if the slide valve spring was of the proper tension or if the slide valve was not lubricated with a heavy bodied oil or grease?

A.—Pressure remaining in the brake cylinder would unseat the slide valve and escape or reduce to a point which would permit the brake piston to recede into the cylinder far enough to open the leakage groove.

941. Q.—What is meant by the term control valve?

A.—The operating valve of the PC equipment.

942. Q.—How many brake cylinders are used?

A.—One for service and two for emergency.

943. Q.—How many exhaust ports are there in the equalizing portion?

A.—Two, the emergency piston exhaust and the reduction limiting chamber exhaust.

944. Q.—How many exhaust ports at the side of the control valve reservoir?

A.—Two, the service brake cylinder exhaust and the application chamber exhaust port.

945. Q.—How many at the bottom of the control valve reservoir?

A.—Two, the quick action exhaust and the emergency brake cylinder exhaust port.

946. Q.—Are there any pipe connections made to the operating portions?

A.—No, except where with certain modifications the exhaust ports of the equalizing portion are piped to a common outlet for all exhaust ports.

947. Q.—Why are all pipe connections usually made to the control valve reservoir?

A.—So that any or all portions may be removed without disconnecting any pipe joints.

948. Q.—What are the two 1 in. pipe connections at the left side of the reservoir when facing the equalizing portion?

A.—The lower one is the brake pipe and the upper one the service reservoir connection.

949. Q.—What pipe connections are made at the right side of the reservoir?

A.—The upper pipe leads to the service brake cylinder, the middle one to the emergency reservoir and the lower one to the emergency brake cylinder.

950. Q.—What is the size of these pipe connections?

A.—One inch.

951. Q.—How is the service brake cylinder exhaust port distinguished from the service reservoir connection?

A.—By remembering that the upper one is the service brake cylinder exhaust port.

952. Q.—How is the quick action exhaust port distinguished from the emergency brake cylinder exhaust port?

A.—The quick action exhaust port is one inch and the emergency brake cylinder exhaust is one-half inch.

953. Q.—Haw many different sized control valves are there for the various sizes of brake cylinders?

A.—But one size for all cylinders.

954. Q.—What are the sizes of reservoirs used with the different cylinders?

A.—

Brake cylinder.	Service reservoir.	Emergency reservoir.
Two 10 in....	14 x 33....	12 x 33
" 12 "....	16 x 33....	14 x 33
" 14 "....	16 x 48....	16 x 42
" 16 "....	20½ x 36....	16 x 48
" 18 "....	20½ x 48....	20½ x 36

955. Q.—How is one of these brakes cut out if defective?

A.—By closing the stop cock in the branch pipe leading to the control valve and opening bleeder cocks in both reservoirs.

956. Q.—How should the brake be bled off if the engine is detached from the car?

A.—By opening both service and emergency reservoir drain cocks until all air pressure is exhausted.

957. Q.—How should reservoirs be bled in the event of brakes sticking?

A.—They should not be bled off, the engineer should release the brakes.

958. Q.—Can the brake be released by bleeding the reservoirs?

A.—Yes, if it is absolutely necessary under conditions where the engineer cannot for the time being increase the pressure to the figure required for a release, opening the service reservoir drain cock will release the brake.

959. Q.—What could be wrong if a brake pipe reduction of 10 or 15 lbs. was made and the brake failed to apply?

A.—In a general way the same things that would prevent the application of a triple valve equipment. If the brake is cut in, and no escape of air accompanies the failure to apply, it indicates that the pressure chamber or the service reservoir is not fully charged.

960. Q.—What could prevent the charging of the pressure chamber?

A.—A restriction in the port leading to it or possibly leakage in the pressure chamber. This latter may be past a very badly leaking lower charging valve ring.

961. Q.—What could prevent the charging of the service reservoir?

A.—A failure of the charging valve to open through excessive friction or excessive packing ring leakage.

962. Q.—How are such defects located?

A.—By attaching air gages to the reservoir and pressure chamber.

963. Q.—What would likely be wrong if the reservoirs were charged and the brake failed to apply with a service brake pipe reduction?

A.—It may be due to either a very badly leaking equalizing or release piston packing ring, or to an obstruction in the application portion.

964. Q.—What else might cause a failure to apply?

A.—A very bad leak past the application piston packing leather and ring.

965. Q.—How could the difference between a leak past the application piston and leaks past the equalizing and release pistons be determined without taking the valve apart?

A.—If the leakage preventing the application of the brake was past the application piston, there would be a noticeable escape of air from the service brake cylinder exhaust port while the brake pipe reduction was being made.

(To be continued)

Hot Boxes on Railway Cars.

"Why Is a Hot Box?" was the subject of an interesting paper read before the members of the Canadian Railway Club recently by E. J. McVeigh, of the Grand Trunk Railway System. Mr. McVeigh displayed a fine sense of humor in introducing his subject. He stated that the hot box first sets fire to the waste and oil in the journal box, then it warms up the temper of the brakeman, this is transmitted to the conductor, and from him to the engineer. Then the dispatcher becomes hot. Then the trainmaster becomes warm and he heats up the superintendent. If there is fire enough it gets up to the president. He might have added that someone gets roasted and everybody is kept in hot water.

Coming to the more serious parts of the paper, the blame was put on bad oil, bad water, bad brass, rough journal, rough truck, truck out of square, overload and general neglect. He might have added a shortage of time and skill, but this might have raised the temperature already sufficiently increased. At any rate a car truck mechanically correct, Mr. McVeigh claimed, requires very little lubrication to keep it running with cool journals. By mechanically correct it is meant that the truck has been properly constructed to do the work it was intended that it should do. The journals on which it rides are of a size calculated to carry the load that they will be called upon to carry, and the saddle, the wedge of proper shape, and the journal bearing of a quality of metal that will reduce friction to a minimum.

If we start out with such a condition, and maintain it, the question of lubrication is so simple that it is practically nonexistant, or it would be if the conditions surrounding the working of a car truck were not so diversified. The cars may be, when loaded, in fair condition, not perfect, but fair. Some of them have new journals and wheels, some of them have old ones. Some new brasses and some part worn. This train starts out with a locomotive that leaves it at the end of 125 miles. The locomotive is carefully looked over by the engineer and then placed in the roundhouse, where other men look it over and do many repairs that are necessary, and it starts out on its next 125 miles run in pretty good order. At least it has had a good deal of attention paid to it.

What about the cars? They are run into a siding and two car men start down the line to inspect the boxes. They pull off the box cover, glance at the end of the packing in sight, see that there is no smoke, close the lid and go on. The engineer when going around the engine places his hand on the big end, the little end, the slide bars and many other parts to know how cool or warm they may be. Does the car man do this? He does not, and the cars start out on another 125 mile run. How many hot journals are there at the end of that run? We do not know, maybe one or six. These receive attention of a kind at this stop, and on they go again. Before they reach the end of the next run some of those that were hot have had several brasses applied to them with more or less success. Some of them are in bad shape and must be stopped for new wheels, the journals have been cut, and some that did not give trouble at the first or second stop are giving trouble now, and so it goes on to the end of the run.

Now, if these journals had all been tested with the hand at the first stop and those showing an inclination to heat given a little attention, and the same thing done as often as the engineer tested his engine, do you believe there would have been so many hot boxes on that train?

Do you agree that the hot boxes on the train we have tried to describe were due to neglect, and was that a fair skeleton description of the average train? Well, then was not it neglect to give the necessary attention that was the cause of 99 per cent. of the hot boxes. Why this neglect? Here is one reason, the railroads haul freight at so low a figure that they feel they cannot afford to have the number of men necessary to give the cars the proper attention. What you can't do yourself you must trust in Providence for, and Providence does not look after box cars. Just here I wish to say that, in my humble opinion the men who design our cars and the men who maintain them come very near performing a miracle in keeping the number of hot boxes so low, considering the adverse conditions under which these cars must operate.

There are many other phases of this question apart from the above, and there is one that is most difficult to deal with. This is the car left at a way station or siding in winter time until the dope is completely frozen, but the car is thrown onto a train and must get along as best it can. However, the better attention at divisional points hinted at above would help greatly in these cases. We cannot, I believe, totally eliminate the hot box on freight cars, but we can reduce the number 75 per cent. by spending the money to do it.

In a Canadian winter our cars do have a hard time of it. Shoved into a yard with snow and ice often scraping the

journal boxes, with the inside heated to 100 degrees and the outside frozen solid, they cannot be in good condition to give satisfactory service. The only answer to that problem is to have the cars placed in a building as engines are placed in roundhouses. Such a building should be heated to about 60 degrees and no heat applied to inside of cars. Two hours after cars are placed in such a building all snow and ice falls away from trucks and running gear, leaving the car clean for proper inspection. The dope remains in the best possible condition, and the car goes out for its run in as good shape as we can make it. I have seen cars handled in this way, and I know that the results were good.

Many people will say that it is impossible to house all of our passenger equipment, or not actually impossible, but that the cost would be prohibitive. We fully appreciate the fact that the cost would be great, that is the initial cost, but it is a quesion if it would not be quite as wise an investment as the roundhouse. It would not be necessary to place every passenger car, mail car and baggage car inside of a building. Many of the spare cars could be left outside as now, but we should have buildings to accommodate all cars on our regular trains with room for a reasonable number of spare cars that should be available in case of accidents.

The cost of such buildings would be considerable, but against this cost, what would we save? This building could be heated with less fuel than is now used for keeping the interior of cars warm while standing out of doors, and that the number of hot boxes could be greatly reduced, or practically eliminated. It is hard to tell just what a hot box would cost, but we know that they cost considerable money. We also have statements from car men to the effect that in one year they have expended sufficient money in repiping cars that have been frozen to pay for a building to protect them. This may be exaggerating, but if the saving in this direction in five years would pay for the building, it would be a good investment.

In the discussion that followed the reading of the paper a description was given of a demonstration with an appliance consisting of a telegraphic relay, an electric bell, with batteries connected to two posts between which was a fusible link that would fuse when the temperature of a journal reached 150 deg. Fah., and the broken circuit would result in operating an electric bell in the coach or sleeping car, and the bill would ring until the box received attention. A spring in the box would be released by the same operation that would drive a plate holding the packing and oil up against the journal, providing lubrication automatically.

Attention was also called to the fact that the conditions during the last few years that the railroads had to contend with were the very worst ever experienced in regard to the lubrication of their equipment. During the war there was a general shortage of railroad equipment and labor was at a premium. The United States Administration and the Canadian Railway War Board worked together, with one thought uppermost in mind—to win the war—and they did everything possible to keep cars moving, so much so that in many cases cars did not receive repairs that would have been considered necessary during normal times. Coupled with this, labor was so scarce that in many cases men were hired who were not efficient railroad workers, and as a last resort car foremen would give them jobs as oilers. Because they were called oilers and believing that their work was pouring oil they managed to get oil cans and poured oil in journal boxes until the wool waste became so wet and heavy that it lost its resiliency, settled away from the journals and in due time hot boxes were the result.

It was also noted that for many years instructions were issued showing the proper method of packing boxes, and many of the roads endeavored to carry out these instructions. They set forth that a roll of waste be formed and applied to the back of the box, then packing put in from this roll up to the inside of the collar at the end of the journal, then a plug or key applied in front of the box, the packing in no case to extend above the center line of the journal. In many cases, however, the packing was put in above the center line, and the front plug was made of such dimensions that occasionally one might open the box cover and fail to see anything but packing. Latterly some of the roads got away from the process by discontinuing the use of the plug entirely. It was found that the practice gave inspectors a better opportunity to examine the box and bearings, and by watching the dry centers of journals, bearings that would likely run hot were detected, the cause discovered and the necessary remedy applied.

Extending Railroad Electrification.

It has been officially announced that as soon as the railroads are returned to their legal owners, electric current will be turned over another 110 miles of main line of the Chicago, Milwaukee & St. Paul railroad, or from Othello to Cle Elum, Wash., including a crossing of the Columbia river. Probably early next year the remaining 135-mile stretch of the road from Harlowton, Mont., to Seattle, will be completely electrified, 885 miles in all, or within 200 miles of half the entire length of the St. Paul-Seattle line. The last stretch from Cle Elum to Seattle, 130 miles, will cost about $9,000,000, or 25 to 40 per cent. more, relatively, than preceding units, on account of higher prices of labor and material.

Vehicular Tunnel Under the Hudson River.

The Sunday editions of the New York press have been giving such glowing illustrations of the proposed vehicular tunnel under the Hudson river that many were misled into believing that work had really been begun on the project. It seems, however, that some real progress has been made. After a dozen of years or more of parleying the joint commissions of New York and New Jersey met recently and signed a contract providing for a tunnel between Canal street, New York, and Twelfth street, Jersey City, the estimated cost being about twelve million dollars. The tunnel is to be exclusively for vehicles and pedestrians. No trolley or subway cars can be used without the approval of the legislatures and governors of the two States.

Jigs

The whole tendency of tool design is in the direction of more "fool-proof" jigs, therefore making more complex and larger jigs necessary. If this can be done with a degree of standardized tool parts, and with easier methods of producing precision work, to avoid trial and error settings when building the tools, there need be no fear for the development and increase of engineering production for the next few years to replace war wastage.

The Metric System

The National Association of Manufacturers of the United States, the British Committee on Commercial and Industrial policy after the war, and the Canadian Manufacturers' Association, after carefully investigating the metric system, individually and collectively report that they are not convinced that the metric system is upon the whole even theoretically superior to the British system, and are satisfied that the practical objections to the proposed change are such as to decisively outweigh any advantages which are claimed for it.

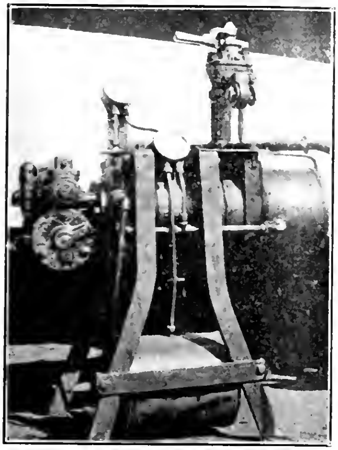
Removing the Sharp Edges.

The turner should remember when machining pulleys, wheels, or drums, or any detail of a similar kind and which is called upon to run at only a fairly high speed, must have all sharp edges removed. Whether the drawing shows it or not, such should be done, for the omission to remove such sharp edges of both the outside and the inside of such pulleys, wheels, or drums is responsible for many serious accidents when such details are running. The edges of such, though feeling fairly smooth and safe when still, become dangerous cutting edges when at work.

Distributing Valve Test Rack.

By George C. McDougal, Foreman Air Brake Dept., A. C. L. Shops, Lakeland, Fla.

The accompanying illustration is a view of a distributing valve test rack for testing Nos. 5 and 6 Westinghouse distributing valve for locomotives equipped with E. T. brakes. This machine was designed and built to meet an emergency. Having found myself in charge of an air brake room 15 ft. by 30 ft., at an outlying division shop, at which point no air brake repair work had ever been done before.



DISTRIBUTING VALVE TEST RACK.

By mounting a double-chamber reservoir on a four-legged bracket and a piece of boiler-plate on top ¼ in. by 14 ins. by 28 ins., for the purpose of clamping an equalizing reservoir on the back end of the double chamber reservoir, to be used to get the brake pipe volume. On this is also mounted a valve "A" of the Westinghouse triple valve test rack, as shown in the reproduced photograph. Underneath the double chamber reservoir is also clamped a second equalizing reservoir, to be used as a brake cylinder volume, by glueing on a No. 5 distributing valve gasket, and cutting an oblong portion out of it about ⅜ in. wide and 1 in. long, leading down from port leading into application chamber, and removing the top stud, and screwing in its place a plug flush with the surface. Both the No. 6 and No. 5 valve can be tested on this compact device.

Holes are drilled into the pressure chamber and application chamber, and fittings applied running air pipes up to a small duplex air gauge, to register pressure chamber and application chamber pressure. Another duplex gauge is mounted near the first gauge to register brake pipe and brake cylinder pressure. By using a spare cap nut in equalizing portion drilled and tapped for ⅜ in. set screw, and by screwing in on this set screw, equalizing piston can be moved far enough toward application position to cover feed groove. Then by using valve "J" in No. 1, 2 or 3, and building up the air pipe pressure, the equalizing piston packing ring is tight.

To note frictional resistance observe the number of pounds necessary to turn into brake pipe with valve "J" before equalizing piston is moved over to release. The rise of the pressure chamber gauge hand will show when the piston has moved to release. If a leak occurs at the pop valve connections, after equalizing valve has graduated this, by removing pop after valve has graduated, and holding thumb over opening, if a leak is noted, it is a sure proof that the graduating valve is leaking.

A plug is also placed in the dead or double-heading connection to double chamber reservoir, and a drain cock in application chamber connection to independent valve, no independent valve being necessary or used. By turning air out of this drain cock from application chamber, when brake or valve is applied, the frictional resistance of application piston can be readily noted by the amount of reduction to get a brake cylinder exhaust at Street "I" exhaust. By screwing a pipe plug into Street "I" exhaust, while brake is applied, then releasing application chamber air application drain cock, any leakage of brake cylinder air by application piston P. K., ring and leather can readily be noted by rise of application chamber gauge hand.

Babbitting Furnace.

By A. C. Clark, Pittsburgh, Pa.

The heating of large pieces of locomotive parts, on which certain surfaces are to be babbitted, is very troublesome, except where special facilities are provided for doing the work.

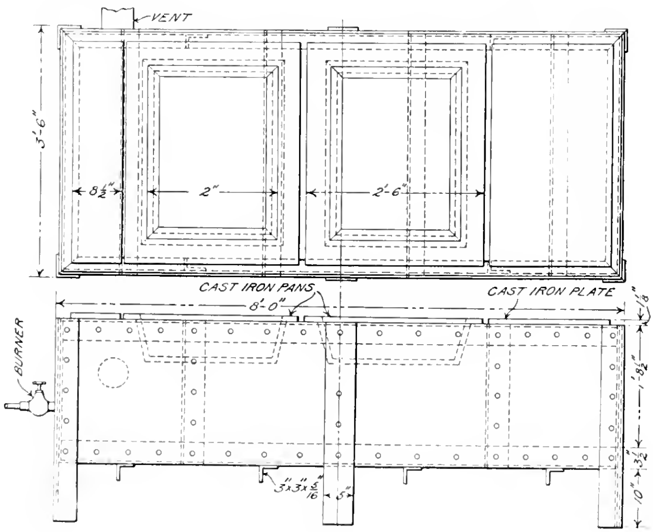
The accompanying engraving illustrates the construction and arrangement of a furnace that is especially designed for the treating of driving boxes, crossheads and similar parts.

It has an overall length of 8 ft. and a width of 3 ft. 6 in. It is so designed that it can be built in any shop. The materials used are ordinary shapes, angles, plates and flats. The four corners are made of ½ in. by 3½ in. by 3½ in. angles extended down to form the legs and thus raise the furnace 10 in. clear of the floor. At the center there is a ½ in. by 5 in. plate that serves as a sort of buckle plate and also supports the central portion. The balance of the framing is formed of ½ in. by 3½ in. by 3½ in. angles, to the bottom of the lower set, of which four 5/16 in. by 3 in. by 3 in. angles are riveted. These extend across the furnace and serve to carry and stiffen the bottom. The bottom is made of a 5/16 in. sheet. The top edge is reinforced by an angle that serves to carry the top plates and pans. The top plate itself is 1⅛ in. thick and made of cast iron and is cut away in two places to receive the pans which are also of cast iron and 1⅛ in. thick. The pans have a depth inside of 6⅞ in.

The bottom sides and ends are lined with firebrick 3 in. thick.

Oil is used for fuel and burner is located at one end, as indicated. The flame is thus thrown into the furnace, and the hot gasses then return to the 5 in. vent shown on the back near the top.

The whole top can be removed if desired, and articles to be heated put on the bottom of the furnace, but for ordinary working the pans are kept in place and the work put in them.



DETAILS OF BABBITTING FURNACE.

Electrical Department

Railroad Electrification

Previous to the war steam railroad electrification was progressing slowly, but consistently. Each year saw some addition to the electrified mileage, and at length some 3,000 miles throughout the country were being operated electrically. But with the increasing cost of materials and the impossibility of obtaining labor for anything except matters of immediate military importance, practically all construction work along the line ceased. However, it required war conditions, combined with one of the severest winters America ever experienced to bring out clearly the advantages of electrification.

Prior to this time, progressive railroad men and electrical engineers believed in the new power, and the public served by electrified lines were well satisfied with it, but there was still much debate as to its general feasibility. But when, last winter, a few feet of snow, a period of zero weather, and the greatest demands for haulage ever known, operated together to play havoc with the steam lines, while the electric lines showed little or no disturbance, all argument against electrification ceased. Public opinion, therefore, now agrees that electrification, in so far as it is practicable, is desirable.

Of course, not even the most enthusiastic advocate of electrification has in mind the electrical operation of every mile of railroad in the United States. This is something that is hardly likely to take place within the present generation, even if the necessary capital for such an undertaking could be found. On the contrary, the most ambitious proposal for a general electrification of the railroads contemplates at present only the electric operation of certain sections, such as terminals, suburban lines, mountain divisions, tunnels that can readily utilize water power, leaving to steam the task of handling the greater part of the mileage for a long time to come.

Even such a limited plan, however, is vast enough in its scope, and to carry it out will keep the constructive forces of America busy for many years. If it were nothing else than a relief to congestion the advantages of electrification are very great. As is well known, it will rarely, if ever, happen that a railroad will become uniformly congested along its entire route. The trouble will invariably appear at some point at which the flow of traffic is restricted, such as at a terminal, at divisions crossing mountains where the speed of the trains is slow, at a tunnel or some similar place. The remedy for congestion must therefore be applied at this "neck of the bottle" or "throat," as such a point is graphically called

The only available remedy is electrification, for the simple reason that electric locomotives can be built with greater capacity than steam locomotives. They can, therefore, haul longer trains at higher speeds. The maximum power of a steam locomotive is about 3,000 horsepower, but there are in operation at the present time a number of electric locomotives of more than 4,000 horse-power. An electric locomotive in operation on the Pennsylvania railroad develops more than 7,000 horse-power, and it is easily possible to apply 20,000 horse-power, or even more to a train if the roadbed and equipment are designed to permit the use of so much power.

As an illustration we may, as has been previously stated in the pages of Railway and Locomotive Engineering, refer to the Norfolk & Western Railway which runs through the rich Pocahontas coal regions of West Virginia and whose service is essential to the welfare of this district. For many years it kept pace with the constantly increasing demands on its facilities, but the time was finally in sight when its full capacity would be reached, and it would be physically unable to handle any additional coal. The situation promised to be not only exceedingly bad for the railroad, but worse for both the producers and the consumers of the coal. An analysis of the situation showed that the difficulty was due to a section about 30 miles long betwten Vivian and Bluefield where there is a very steep grade against the traffic and a long tunnel. Elsewhere the long coal trains moved freely enough, but here three of the largest Mallett steam locomotives on each train could not move the traffic more rapidly than seven miles an hour. In consequence congestion occurred at this point and set the limit of the capacity of the entire system for the important east-bound movement.

To solve this problem, this difficult section was electrified and now huge Baldwin-Westinghouse electric locomotives haul the trains up the mountainside at 14 miles an hour, and in this way the capacity of the entire system has been more than doubled.

The Broad street station of the Pennsylvania railroad at Philadelphia, offers another illustration of the ability of electricity to increase the capacity of existing equipment. The trouble there was due to the fact that the tracks just outside the station had to be used more times in the process of changing an incoming steam train into an outgoing one. The tracks were thus in constant use, and incoming trains were frequently held just outside the station for long periods waiting for a chance to enter. It was impossible to increase the number of tracks, for the right-of-way already occupied the full space between two important city streets, but electricity offered a way out. Electric motor trains, being alike at front and rear, can run in, discharge their passengers, take on a new load, and run out, thus using the outside tracks but twice. Hence by electrifying the suburban lines using Broad street station, the tangle of moving cars has been eliminated, and the station has ample capacity to handle the traffic for many years to come.

Probably the most striking illustration in point of economy is the 440 miles of road over the Continental Divide. The reports of the Chicago, Milwaukee & St. Paul railway, which operates electrically that portion of the road, announced a saving of 500,000 tons of coal and 250,000 barrels of fuel oil a year. A fair estimate shows that every mile of railroad operated by water power transformed into electricity means a saving of over 500 tons of coal per year. For geographical reasons, however, it is hardly possible to employ water power for all railroads, especially those east of Chicago and north of Richmond.

In the matter of repairs, retirements and depreciations, for handling 1,000 tons one mile, the reports of the Norfolk & Western railway show that the cost in the case of steam locomotives is 32 cents per mile, and 10 cents for electric.

The cost of electrifying a railroad is made up of five main items: The overhead power line, the locomotives, the substations (for transforming the high-voltage power received from the power house into power suitable for use by the locomotives), and the power house. Naturally, this cost will vary widely with conditions. For example, the electrification of the Chicago, Milwaukee & St. Paul Railway which carries light traffic, cost about $30,000 a mile exclusive of the power house, current being bought from an independent hydroelectric system. On the other hand, the electrification of the Norfolk & Western Railway, a heavy traffic road, cost about $100,000 a mile, including the power plant. These figures can be taken as a minimum and maximum respectively, although specific instances of both higher and lower costs could be easily pointed out. Taking average railroad conditions, however, the cost of electrifying a mile of track is estimated at $50,000, including the cost of the power house and using pre-war prices.

Electrification is therefore an expensive matter, but the expense is justified from point of view of the railroads by the fact that, when congestion does occur, the

burden of electrifying is less than that of handling the excess traffic, or of remedying the situation in any other way; while from the point of view of the public, the breaking down of a railroad's service must be prevented by any possible means. Then, too, the national advantages of fuel and labor conservation must be considered.

How the railroads are going to secure the necessary capital to undertake a general electrification is at present an unsolved problem. But since the people of the United States will be the chief benefactors from electrification, it seems logical to place the cost upon them. It is therefore possible that the Government may advance the necessary funds, to be paid back gradually by the railroads from the resulting savings. At all events, since future traffic conditions demand electrification, its general adoption, however, affected, is inevitable.

THE ELECTRIC RAILWAY.

A Potential Factor in Relieving Freight Congestion.

The Chamber of Commerce of the United States fully realizes the importance of the electric railway as a valuable utility and has asked authorities to give prompt and sympathetic hearing to utility petitions for assistance and relief due to the unusual financial conditions. Increased rates are of necessary and vital importance to the utilities, but even more important to the government is the development of electric railway freight haulage.

The spirit of the age is conservation. The prodigal use of man-power cannot be permitted to continue. Millions of tons of freight can be moved by the electric lines with only a slight increase in men, as compared with highway transportation. The handling of 500 tons of freight by motor truck would require at least 100 men driving 100 five-ton units; but by electric railway it would only require three or four men, and this same crew could easily handle four times as much freight. The electric railway requires but one man for every thirty to handle the same tonnage by motor truck, not counting the extra men needed to maintain and repair the highways. The investment in rolling stock alone, to haul 500 tons of freight is easily one to ten in favor of the electric railway, including the electric locomotive.

Inherent operating conditions on electric railways permit the realization of potential possibilities that are of great significance in this day of car shortage. One electric freight trailer car in service is equivalent to five steam road freight cars, and one electric motor car, which may haul several trailers, to three steam freight cars. This is conclusive evidence of the high load factor or efficient utilization of freight rolling stock possible on electric railway systems.

The actual everyday ways of using the electric railway to move more freight and help win the war are humanly interesting. Long before the war the electric railway had shown its ability as a freight carrier and valuable public servant. For years the railroads of Iowa have been hauling the grain and stock from our prairies. Notably among these are the Fort Dodge, Des Moines and Southern Railroad, Interurban Railway of Des Moines and the Waterloo, Cedar Falls & Northern Railway. Each of these lines is the equivalent of a steam railroad with a trolley wire over it.

The Waterloo, Cedar Falls & Northern Railway is the pioneer electric line to arrange with the steam railroads for the interchange of freight. As a result, more than 70 per cent. of the switching from steam roads entering Waterloo with its 155 factories is performed by this line. Similarly, several steam trunk lines entering Cedar Rapids are fed by the electric line since it serves a northern territory that does not enjoy adequate steam service.

In the Central States, where the electric railway has long been considered as one of the most important factors in the economic development of communities, the electric lines are not only hauling passengers, but are carrying all classes of freight commodities. Indianapolis, the interurban center of the country, now has freight handling facilities completed and under construction that would do justice to many a steam road freight terminal. One item of great significance, when considering the electric line as a factor in relieving freight congestion and alleviating public suffering, is of timely interest. Last winter, due to car shortage on steam lines, it was impossible for farmers to secure cars for hauling their hogs and cattle to the Indianapolis market. The Food Administration appealed to the electric lines and during the winter months over 1,000 carloads of hogs were brought to this market. The Chicago, North Shore & Milwaukee Electric Railroad, which skirts the western shores of Lake Michigan between Chicago and Milwaukee, is in an excellent position to serve the numerous fast-growing industries located along its lines. The shippers of this territory already recognize the great value of the reliable service rendered by the line. The traffic has grown so fast that even with the erection of new freight houses many of these are not large enough to take care of the ever-increasing quantities of freight offered for transit.

Camp Dodge, Iowa, with accommodations for 25,000 troops, was constructed from material hauled in 10,563 standard steam road cars during seven months over the 12 mile line of the Interurban Railway of Des Moines. This included the transportation of building materials, supplies, food, munitions, cattle and horses. At the time this camp was established it was thought impossible for the electric line to handle all the traffic. However, neither of the two steam lines, the furthest of which was only three miles away, cared to extend their lines into the camp. Hence, all freight had to be interchanged with the electric line. The service has proved satisfactory beyond all expectations.

It is evident that immediate relief can be secured for the steam railroads through assistance from an existing facility which only needs proper fostering to become at once an important factor in our present national emergency and for the future.

In order, therefore, to affect this relief there should be: Universal interchange of freight rolling stock between steam and electric lines that can handle steam rolling stock, and Federal financial aid to those electric lines which, with this assistance, could carry this additional traffic. Co-ordination of all transportation facilities. Steam railroads for long hauls. Electric railways for short hauls, eliminating duplication of passenger and freight service between steam and electric lines. Motor trucks to serve industrial centers; to be available for unloading freight cars arriving at terminals, thus releasing them for immediate reloading, and to act as feeders to steam and electric lines from districts lacking rail facilities.

Electric Traveling Cranes.

The Chesapeake Iron Works of Baltimore, Md., manufacturers of the Chesapeake Electric Traveling Cranes, have recently announced the opening of its New York office in the Woolworth Building. The office will be in charge of H. L. Mode. The Chesapeake is known as "The Most Rugged Crane Built" because of the structural strength, ruggedness and rigidity of its wearing parts. While the Chesapeake crane is standardized, they are made in all types and sizes in any capacity, to meet every service condition. Chesapeake cranes were selected by the United States Government and over forty-five were used by the Base Ordnance Department in France during the war.

Electrification of German Railroads.

It is reported that Germany is considering the project of establishing electric high-power plants in coal regions and the current carried from them along the lines. It is said to be the best proof of the pacific intentions of Germany. A new war would give the enemies of Germany an opportunity of destroying one or two central stations and thus stop all German railway traffic at a single blow and ruin the economic life of the country.

Further Details as to Electric Welding Systems

By J. F. Springer

In the preceding article, it was pointed out or implied that there are several varieties of arc welding. In the one, the rod which furnishes the fresh material for the weld is used as one electrode, while the work formed the other. This rod is covered with fusible flux. This system is attributed to Oscar Kjellberg, of Gothenburg. The work is negative to the electrode, and this results in the deposition of metal from the electrode onto the work. Another variety of arc welding mentioned is the one where a carbon electrode is employed. This system is attributed to Nicholas de Benardos and Stanislas Olzewski—both of Petrograd. The hand electrode here is negative to the work, just the opposite to what we had in the case of the covered metal electrode. There is an advantage in both cases. In the preceding system the particles from the diminishing metal electrode are deposited on the work, where in fact they are wanted. This permits vertical and overhead welding. In the present case, where the hand electrode is carbon, the fact that the carbon is made negative insures that the current will not tend to inject carbon into the heated metal. This is very important, as otherwise highly heated steel would undoubtedly be carburized and thus suffer a change in its character. A third variety of arc welding mentioned in the preceding article is the one which uses an uncovered metallic electrode. This system seems to have been due to a Russian by the name of Slavianoff. Apparently, it has been used but little in England.

There is really a fourth variety of arc welding, that attributed to Dr. H. Zerener, of Berlin. In the Zerener system, two carbon electrodes are used. The arc is formed between the carbons. In order to cause it to flow against the work an electro-magnet is employed. The Voltex system is understood to be an improvement upon that of Zerener. The carbon electrodes are made up with a small percentage of metallic oxides in them. A suitable oxide is one based on iron. During the operation of the arc, the oxide is decomposed and vaporized. The arc, it seems, is enlarged by the vapor and the carburization of the work is reduced or eliminated. However, so far as I know, neither the Zerener nor the Voltex systems has attracted much commercial attention in the United States.

The method was also mentioned which passes the current through parts in contact and develops, especially at the surfaces of contact in the path of the current, a high heat. Combining pressure with this heat a weld is formed. This is resistance welding, invented by Prof. Elihu Thomson. Spot welding is to be regarded as an outgrowth of this system.

I will now seek to indicate the order in which the various systems were invented, but cannot vouch for all details.

SYSTEM OF ELECTRIC WELDING

1. The Thomson resistance system.
2. The Benardos-Olzewski system, which uses a carbon electrode. 1885.
3. The Zerener system, using two carbon electrodes and an electro-magnetic deflector. 1890.
4. The Slavianoff system, which employs a bare metallic electrode. About 1895.
5. The Kjellberg system, which uses a covered electrode. 1907.

It will be understood, perhaps, without my saying it, that naturally the several methods are especially adapted to their own peculiar fields of activity. It is not always a question of one being better than another. Often, one or two of the systems will be best adapted to a certain class of work. For a different class of work, still another system may have the greatest suitability. It will be of advantage, then, to have before us more or less information as to the several fields of activity. I must warn the reader, however, that I am not engaged in passing judgment on the various systems and defining with any finality the comparative suitability. The reader is to understand that when I say that a certain system is well adapted to a certain class of work and am silent as to this work in connection with another system, he is not to draw any inference at all from my silence. He is, by no means, to understand my silence as having any disparaging force whatever. Unless I plainly say that such and such systems are not suited to such and such work, he is to understand nothing at all in respect to unsuitability.

With further reference to No. 1, i.e., to the Thomson resistance method, it may be noted now that it is suited to the welding of ordinary bars, angles, T-bars, and miscellaneous rolled sections, tubes, tires for wheels, metal rims for motor vehicles, frames, chains, wire netting—all this may be handled with advantage by resistance methods. Wire of mild steel, even if of quite small cross-section, belongs to the class of work done by this system. Even copper wire is to be included. Machines are usually employed to control work, current and the mechanical pressure employed. It is proper, under this system, to use the hammer as an assistant, especially if the work is heavy. That is, while the work is still in the jaws of the machine, it may be of advantage to assist with the hammer in the process of forcing them together. Sometimes, presumably when the work is quite irregular, there may be an uneven distribution of current. The effect is to heat unevenly. The head of the hammer may at times in such cases be employed as an additional conductor for the purpose of increasing the flow of current at a deficient point. Naturally, the heating of the work tends to result in heating the machine jaws which hold it. As a corrective of this, the jaws are made hollow and are cooled with water.

There are two jaws which hold the work as if it were in a vise. The one jaw is fixed, while the other is movable. Some large machines employ power in shifting the movable jaw. Some are of a size to permit the shift to be made by hand.

This system may be operated in two ways. Either an inconsiderable current is given a considerable time or a heavy current is employed for a brief period. Naturally, we thus get slow and fast operation. In the slow procedure the metal heats up gradually. The operator, hammer in hand, has time to note deficiencies of current flow and to correct them with a blow of the hammer or its use as an auxiliary conductor. The voltage may be very low—say, 1 or 2 volts. While the metal is, naturally, overheated, it need not be burnt, it seems, when the slow procedure is employed. Overheating is to be regarded as an evil necessary in practically all systems of welding, whether in the system used from old time by blacksmiths or in the new gas and electric processes. But burning is a step farther. When steel is burnt, one understands that carbon has actually been consumed and the steel more or less destroyed. The fast method of resistance welding makes use of such a heavy current that metal is burnt at the joint. However, the pressure of the machine is managed so as to operate in the direction of forcing out burnt metal from between the surfaces undergoing welding. There will be a fin or ridge left when the work gets cold. This will likely consist of metal more or less burnt. It is removed cold by grinding or otherwise. The voltage employed is low: it may, for example, be only 2 or 3 or 4 volts.

System No. 2, the Benardos-Olzewski process, which uses a carbon electrode, is suited to a great variety of work. Thus, such work as the manufacture of steel barrels, drums and tanks has been

done for a quarter of a century or more. Instead of the weld being carburized steel, it is said by Mr. T. T. Heaton, of the (British) Institution of Mechanical Engineers, that it is soft and of a purer iron than the original metal. This result is due, no doubt, to the direction in which the current flows. This point has already been indicated. He himself, apparently, uses direct current at about 90 volts and at from 250 to 500 amperes. The variation in amperes is required by variations in the thickness of the work. The weld may be a hammered one or a fused one. By this we are, presumably, to understand that the union of the softened metal may be assisted by the hammer. Doubtless, a less temperature may then be used. With a fused weld, there is actual melting. Any difference in quality may be taken advantage of and the mode of operation made to correspond to the class of work in hand. With this system of arc welding a very considerable arc may be built up. Thus it is not at all impossible to get an arc 1½ or 2 inches in length. The heat may be distributed over a good sized region. This is, in effect, claimed as an advantage in preventing such acute concentrations of heat and the consequently severe local stresses. Rather rapid operation is possible. The time required to weld a seam 1 foot long in mild steel 0.14 inch thick need not be over 2.76 minutes. This time includes the heating-up operation and all hammering to make the work petroleum-tight. The rate at which carbon electrode is consumed may be understood somewhat when it is said that it requires 8 inches of good-quality carbon 0.6 inch in diameter to weld a 50-foot seam in mild steel ⅜ inch thick.

System No. 5, the Kjellberg process of using a covered metallic electrode, is one which has had extensive application abroad. The voltage used may vary, say, from 45 to 90 volts. The average electrode will have a diameter of about 3/16 inch and consist of soft iron. Mild steel plates, having a thickness of ¼ to ½ inch, may properly be welded with a current of 145 amperes. Heaton says: "It is not found to be really satisfactory to apply this system to work in mild steel to thicknesses of plate below ¼ inch. The author has tested welds in thinner material, but would consider them less satisfactory than hammered welds made with a carbon electrode. The heating is more local and cannot be spread as with the free carbon electrode."

There is a system using a covered electrode which appears to be more or less related to the Kjellberg procedure. This is the Strohmenger process. It is, essentially, the system described in the preceding article, which used blue asbestos yarn and permits aluminum wire to be wound with it. "This system appears to be best suited for thicknesses above 3/16 inch thick, though, as in the Kjellberg process, thinner metal can be welded. The speed of welding is relatively greater for the greater thicknesses in comparison with that of oxy-acetylene welds, but it is much less than with the carbon electrode up to ¼ inch."

Snap Shots

By the Wanderer

I ran across a letter the other day that was written several years ago to the editor of a paper by an engineer, who had been requested by the said editor to contribute to his columns certain articles bearing on the railroad situation and tending to set forth the woes and wrongs of a suffering public. It was at a time when it was quite the fashion for the demagogic politician and the newspaper of the yellow tinge to pitch into railroad management. Since that time the unthinking public has reaped the full benefit of the policy it so warmly encouraged. The letter does not refer to the present situation, but, in the general expression of its opinions, it is quite apropos, and is quite worth while the serious consideration of those who carry any gray matter at all above their eyes. Here it is:

"The letter of the 25th, from your business manager, has just been received, and I think it would be far better for you and those interests that you claim to represent to make a study of what you and they are actually receiving from the railroads, than to stir up more muss by trying to find out a few minor delinquencies which may be used as a means of inciting discontent. Just see if you and they are not receiving full value and far more for all the money that you pay than that there may be some possible loophole into which you can stick a wedge of complaint. I tell you frankly that I not only do not think that you or they have any cause for complaint, but have much for which to be thankful. And, in all that you do, please remember that the railroads are not heartless corporations who can be pounded and injured without compunction, but that they represent the savings of thousands of investors or charitable institutions, or colleges and the great mass of associations engaged in public welfare work, and that they need help in what they are trying to do instead of the bludgeon of a demagogue. Remember that when you strike a blow at their credit, you are striking a blow that will prevent them from making the improvements that will give you a better service and that the blow will rebound and hit your own skull before its force is spent. So, if you want my opinion, it is that your paper could not engage in a dirtier piece of work than in a campaign against the railroads to which it owes its very existence."

Certainly the blow did rebound and few are the skulls, innocent or guilty, that have not been hit thereby.

The electrolytic theory corrosion as developed and proved by Dr. Allerton Cushman so fully accounts for all the various phenomena attendant upon the corrosion of iron and steel that it is accepted throughout the scientific world as established beyond all peradventure. But theories of this character are too often regarded as pure theories by the practical men of affairs; something belonging to the laboratory and the domain of scientific investigation and as having little or no connection with the affairs of everyday life, or at least to be possessed of such a refinement as to have little or no influence upon them. In short, this is a decided mental distinction drawn between the action of a piece of steel subjected to the delicate tests of a laboratory experiment and the performance of a similar piece in the rough service that it has to perform in the firebox of a locomotive.

That this is a mistake, almost anyone will concede. And because this matter of corrosion is one of the serious troubles of locomotive boiler mainteance it is urged that too much attention cannot be paid to the selection of steels that are used therein.

The whole electrolytic theory of corrosion is based upon the development of electric currents by the non-homogeneous character of the metal, and the greater this variation in structure and composition the more rapid will be the corrosion. This is a simple statement of cause and effect.

Hence it follows that he who would suffer the minimum of trouble from corrosion must pay the maximum of attention to the selection of his steels and irons, other conditions remaining the same. This is not to assume that the sole precaution to be taken against corrosion lies in the selection of the steel, for there is such a thing as a corrosive water, but, as Kipling would say, that is another story.

Is the microscope too refined for use in connection with the selection of a boiler steel? Can it be used successfully by the man who has not had years of training in its manipulation and in drawing conclusions from its indications. To both of these questions an affirmative answer can probably be made with safety. If the observer desires to determine an approximation of the carbon content of a piece of steel, it is probable that, unless he has had considerable training, he will vary so far from the true mark that he had best discard his microscope and betake himself to the chemist. But for detection of defects in the material, such as the inclusion of slag, minute blowholes, and variation in structure the microscope will tell a story to even a lay operator that can be told in no other way. A recent microscopical examination of some boiler steels gave a vivid example of how a piece of steel that had passed all inspection and was presumably of a high grade, was shown to be really unfit for the service to which it had been applied; simply because of the great variation in its structure between surface and center, that could have been detected in no other way.

The preparation of the specimens is exceedingly simple, and an instrument with lenses arranged to magnify from 20 to 100 diameters will serve all the purpose of a quick and accurate means of determining the general structural character of a piece of steel or iron. It will frequently make it possible to decide at once in the choice between two brands and the probable relative results to be obtained from them. It tells a very vivid story of structure and enclosed impurities that can be read in no other way, and to those who are shown it without previous knowledge of what they are to see, the indications are usually quite startling.

In the discussion of the Boiler report at the Master Mechanics' convention of a year or so ago, attention was called to the sensitiveness of firebox sheets to in drafts of cold air when the door was opened and the great changes of temperature that occurred. It seems fair to presume that if a sheet is cooled it contracts with the same rapidity with which it cools, and that if there is a local cooling, as seems probable, corresponding stresses are set up in the boiler. Hence if the door opening can be avoided, so will the cooling and straining, and repairs ought to be less.

If a shovel is used the door must be opened, but if the engine is equipped with a stoker that makes any approach to one-hundred per cent. work, then all of this temperature variation and the accompanying stresses in the boiler parts ought to be avoided. It looks as though it were a pretty good argument for the introduction and use of the stoker independent of its labor possibilities.

We have been talking indefinitely about the value of circulation in a steam boiler for years, and yet little has been done to promote it. In marine boilers, yes. In locomotive boilers, no. If it is a good thing why all this indifference by men who are preaching and practicing efficiency to the utmost? Probably because it isn't worth while. As for promoting evaporation, it is difficult to see why merely passing water over a sheet should have that effect. Water cannot be heated above the temperature due to the steam pressure and the rate of heat absorption depends on the difference in temperature between the fire and water sides of the sheet. So, if water is in contact with the sheet, what difference does it make whether it is moving or not so far as evaporation is concerned?

In some water-tube boilers and those of the Scotch type the circulation is notoriously slow, and means are taken to accelerate it, not so much to increase evaporation as to equalize boiler temperature, and thus prevent undue stresses on the sheets. For this, all hail a rapid circulation.

It may also be of value, in some places, to prevent scale deposition. So, for this and for temperature equalization a rapid circulation is of value, but when it comes to saving money at the coal pile, there is not much, if any, data at hand to show that it is of any use. Hence when we urge the value of a rapid circulation it is well to bear in mind what we can reasonably expect to accomplish by it. For data on the subject reference is made to the Coatesville tests, in which an evaporation of 12 lbs. of water per square foot of heating surface per hour was obtained with a circulation of about 2 ft. per second in the water legs of the boilers; and yet, even with that slow circulation, the water at the back end of the water leg at the mud ring only lacked four degrees of being at the steam temperature.

Fair Profits.

It is interesting to observe from the reports of British exports and imports which are now reaching us with a degree of fulness unknown during the war period that the profiteer, so-called, is, generally speaking, no profiteer at all. Taking one of the staple industries as an example the output of coal in Britain in the years previous to the war, and which amounted to 270,000,000 tons. The price at the mines was $2.12 per ton. The profit, as shown by the unimpeachable Board of Trade investigation, was 24 cents per ton. In 1918, the last year of the war, the output is placed at 232,000,000 tons, the price at the mines being $6,04, and the profits per ton 86 cents. It will thus be seen that while the price of coal at the mine has nearly trebled, the net profit is now 350 per cent. of what it was during the 1909-13 period. At the first glance this looks like profiteering, but the profits have not all gone into the pockets of the mine owners, for the reason that under the excess profits taxation they are entitled to only 5 per cent., the remaining 95 per cent. being payable to the National Treasurer. Of course, a certain element in Great Britain, as in the United States, do not care to trouble themselves about the involved rates of taxes and sur-taxes, but surely 5 per cent. cannot be called other than a fair profit.

Railway Construction in Canada.

The construction of new railway lines extending to nearly 400 miles has been announced by the Canadian National Railways. The new lines, of which there are about a dozen, are mostly in the province of Saskatchewan. The longest line projected, and on which work has already been begun, is a branch running from Hanna-Medicine Hat, Alberta, into a rich agricultural district, a distance of 72 miles.

A New Lubricant.

A new fruit containing a large percentage of oil has been discovered in the region of Torreon, Mexico, and is known by the name of chichopoxtle. Experiments show that 25 per cent. of its contents consist of oil of great value in industrial pursuits requiring a lubricant of high quality. It is proposed to introduce the cultivation of this fruit upon a large scale.

The Best Boss.

The best boss is said by an eminent authority to be the one who is least of a boss, the one who gives men the fullest opportunities to develop themselves, to grow to the limit of their capacity. The one-man concern cannot amount to much in these days of big things. It takes a big, strong, well-organized team to grapple with modern conditions, and to turn the wonderful present-day opportunities to profitable account.

Locomotive Front End Leaks.

Using the blower to create a draft and holding a lighted torch to all seams and joints in the front ends of locomotives readily locates all leaks of air which obviously increase the amount of gas and air that must be moved by the exhaust jet, and consequently necessitates a reduction in the size of the nozzle tip. This, of course, increases the cylinder back pressure and entails fuel losses. Such defects should be promptly reported.

Items of Personal Interest

A. R. Tegtmeyer has been appointed roundhouse foreman of the Chicago, Milwaukee & St. Paul, at North La Crosse, Wis.

S. Lenzner, master car builder of the Michigan Central, at Detroit, Mich., has been appointed supervisor of passenger equipment.

H. G. Griffin has been appointed general superintendent of the car department of Morris & Company, Union Stock Yards, Chicago.

J. M. Strong has been appointed division storekeeper of the Schuylkill division of the Pennsylvania, Eastern Lines, with headquarters at Reading, Pa.

G. R. Miller has been appointed division foreman of the Santa Fe at Gallup, N. M., succeeding W. J. Burhard, who has been transferred to Los Angeles, Cal.

J. C. Brekenfeld has been appointed shop supervisor of the St. Louis-San Francisco, with headquarters at Springfield, Mo., succeeding A. J. Devlin.

S. A. Schickedanz, chief draughtsman of the Chicago & Eastern Illinois, has been promoted to mechanical engineer with headquarters at Danville, Ill.

James Walker has been appointed assistant roundhouse foreman of the Santa Fe at Dodge City, Kan., succeeding A. Walker, appointed drop-pit foreman.

C. L. Whitman, master boiler maker of the Chicago & North Western, at Huron, S. D., has been transferred to Milwaukee, Wis., succeeding E. J. Nicholson, promoted.

A. H. Powell has been appointed general master mechanic of the Western Pacific, Tidewater Southern and the Deep Creek railroad, with office at Sacramento, Cal.

T. M. Bryden, lately returned from military service, has resumed his former duties as chief dispatcher of the Chicago, Rock Island & Pacific, with headquarters at Pratt, Kan.

C. A. McCarthy, general foreman of the Rock Island at Cedar Rapids, Ia., has been appointed master mechanic of the Chicago, Milwaukee & St. Paul, with office at Perry, Ia.

William H. Menner, road foreman of engines on the Erie, with office at Jersey City, N. J., has been appointed supervisor of locomotive operation, with the same headquarters.

Captain S. E. Mueller, having returned from military service, has been appointed general foreman of the Rock Island shops at Cedar Rapids, Ia., succeeding C. A. McCarthy, resigned.

W. J. Burhard, division foreman on the Atchison, Topeka & Sante Fe, at Gallup, N. M., has been transferred to Los Angeles, Cal., and G. R. Miller succeeds Mr. Burhard at Gallup.

A. M. Meston has been appointed district road foreman of engines and oil-burning inspector of the Southern Pacific, with headquarters at Los Angeles, Cal., succeeding F. W. Corcoran.

F. P. Miller, master mechanic of the Chicago, Milwaukee & St. Paul, at Marion, Ia., has been transferred to Portage, Wis., succeeding M. F. Smith, transferred to Minneapolis, Minn.

Captain W. C. Irwin, having returned from army service, has been appointed sales representative of the Dunbar Manufacturing Company, with offices in the Frisco Building, St. Louis, Mo.

J. C. Cole, master mechanic of the Rock Island at El Dorado, Ark., has been transferred to Dalhart, Tex., and W. M. Wilson, master mechanic at Dalhart, has been transferred to El Dorado.

C. H. Holdredge has been appointed general air-brake inspector of the Southern Pacific, lines south of Ashland, with headquarters at Los Angeles, Cal., succeeding A. M. Meston, promoted.

H. L. Moore, road foreman of engines on the Southern Pacific at Tucson, Ariz., has been transferred to the Coast division, with headquarters at San Francisco, Cal., succeeding C. H. Holdredge, promoted.

Lawrence A. Rowe, mechanical inspector of the Atchison, Topeka & Santa Fe, has resigned to accept an appointment as general manager of the Universal Packing & Service Company, with office at Chicago.

J. A. Laughlin, storekeeper on the New York Central, at Elkhart, Ind., and Herry Stephens have been appointed assistant general storekeepers on the lines West of Buffalo, with headquarters at Collingwood, Ohio.

H. K. Morrison, resident engineer of the Superior division of the Canadian National Railways, with office at Hornepayme, Ont., has been appointed division engineer, a newly created position, with the same headquarters.

A. R. Hodges, formerly master boiler maker of the Santa Fe at Topeka, Kan., and later with the Frisco System at Memphis, Tenn., has been appointed general foreman of the New York Engineering Company, Yonkers, N. Y.

R. D. Anderson, assistant engineer on the Minnesota & Dakota division of the Chicago & North Western, has been appointed to the newly created position of special engineer in the accounting department of the road with office in Chicago.

W. Malthaner, general master mechanic of the Northwest district of the Baltimore & Ohio, Western Lines, with headquarters at Cleveland, Ohio, has been appointed acting superintendent maintenance of equipment, with headquarters at Cincinnati, Ohio.

O. R. Anderson has been appointed division storekeeper of the Nebraska division of the Chicago, Rock Island & Pacific, with headquarters at Fairbury, Neb., succeeding T. Beard, transferred to the St. Louis division, with headquarters at St. Louis, Mo.

J. F. Jennings, master mechanic of the Michigan Central, at Bay City, Mich., has been appointed assistant superintendent of motive power, with headquarters at Detroit, Mich., and J. O. Goodwin, road foreman of engines at West Bay City, Mich., succeeds Mr. Jennings at Bay City.

C. J. Wymer, sales representative of the Grip Nut Company, of Chicago, and formerly general car inspector of the Chicago & Eastern Illinois, has been appointed general superintendent of the car department of the Chicago & Eastern Illinois, with headquarters at Danville, Ill.

H. V. McKedy, formerly assistant to the vice-president in charge of sales of the American Locomotive Company, has accepted an appointment as Eastern railroad representative of the Glidden Company, of Cleveland, Ohio, with headquarters at 636 West 34th street, New York City.

H. E. Byram, Federal manager of the Chicago, Milwaukee & St. Paul, with headquarters at Chicago, has been elected president of the corporate organization, and R. M. Calkins has been elected vice-president. B. B. Greer has been appointed Federal manager, succeeding Mr. Byram.

J. B. V. Duer, assistant engineer on the Pennsylvania, at Altoona, has been appointed electrical engineer, and S. M. Viele has been appointed assistant electrical engineer of the new electrical engineering department operated in connection with the mechanical engineering department at Altoona.

W. F. Kiesel, Jr., acting mechanical engineer on the Pennsylvania, at Altoona, Pa., has been appointed mechanical engineer, and H. A. Hoke, acting assistant mechanical engineer at Altoona succeeds Mr. Kiesel; R. N. Miller, assistant engineer at Altoona, succeeds Mr. Hoke, and B. S. Brown succeeds Mr. Miller.

W. G. Johnston, master mechanic of the Newark division of the Baltimore & Ohio, with headquarters at Newark, Ohio, has been appointed master mechanic of the Northwest district, with headquarters at Cleveland, succeeding Mr. Malthaner, and F. E. Cooper, shop superintendent at Newark, Ohio, has been appointed to succeed Mr. Johnston.

K. C. Gardner, assistant manager of sales of the Pressed Steel Car Company and the Western Steel & Foundry Company, has been appointed manager of sales of the Central district, with office at Pittsburgh, Pa., and Huntley H. Gilbert, assistant manager of sales, has been appointed manager of sales of the Western district, with office at Chicago.

Colonel Clarence S. Coe left New York last month to represent the Advisory Mission in Serbia. He will have charge of the rehabilitation of the railroads in Serbia and Jugo-Slavia. J. H. Nelson, formerly general superintendent of the Florida East Coast Railway, and Captain McMillan, of the Transportation Corps, will be operating and mechanical advisors of Colonel Coe.

Lieutenant-Colonel Russell W. Stovel, recently returned from France, where he served as chief of the terminal facilities of the transportation service, has been appointed a consulting engineer of Westinghouse, Church, Kerr & Company, and will devote his entire time to the company's electrical and mechanical work.

LIEUT. COL. RUSSELL W. STOVEL.

Colonel Stovel has had an unusually comprehensive experience in the electrical and mechanical problems connected with central power station and steam railroad electrification work. He is a graduate of McGill University and is a member of the American Institute of Engineers and the American Society of Mechanical Engineers.

The appointment of Frank Hedley to the presidency of the Interborough Rapid Transit Company, New York City, has been received with universal approbation, not only by all who have the honor of his acquaintance, but by the press and public generally and railroad men particularly. His career is worthy of more than a mere passing notice, as without much education or without influence of any kind he has risen by the sheer force of merit. He had some early advantages, as his father, a typical English gentleman, was

FRANK HEDLEY.

master mechanic on the Southeastern railway of England, and his great-granduncle, William Hedley, designed and built the first locomotive traction engine in 1813, which was used for hauling coal on the Wylan railway, and is now in the South Kensington Museum, London. It was from this engine that George Stephenson obtained his ideas for his improved locomotive which he built in 1825.

Frank Hedley learned the machinist's trade and came to America at an early age, and worked in the Erie and New York Central. His first promotion came as assistant general foreman on the Manhattan Elevated railway in the locomotive department. In 1889 he was appointed master mechanic of the Kings County Elevated Railroad, Brooklyn, and in 1893 general superintendent of motive power and rolling stock of the Lake Street and Northwestern Railway System in Chicago, besides consulting engineer in the Chicago Union Loop. His experience in electric traction in Chicago led to his appointment as general superintendent of the Interborough Rapid Transit Company, New York, in 1903, and general manager the following year, and in 1908 the duties of vice-president were added. In 1912 he also became vice-president and general manager of the New York Railways Company, which operates surface lines in Manhattan, and vice-president of the Rapid Transit Subway Construction Company.

During this period of incessant activity, Mr. Hedley has found time to perfect many improvements in the mechanical devices used in electric traction, many of which are patented. He is one of the very few railroad men who have obtained a complete mastery both of the steam engine and the electric motor with all their multiplex accessories. In middle life, he still retains the elasticity of youth, and, largely self-taught, he is still a student, and whether as a mechanic, a manager, a platform orator or in the witness box before an investigating commission, he knows how to hit the nail on the head, and in and through all this he remains the same unaffected, clear-headed, warm-hearted man of the world. His marked success in his chosen sphere of action has neither given him a swelling of the head nor a contraction of a heart. He is what the Latins called, "rara avis in terra firma," a rare bird on earth.

OBITUARY

M. K. BARNUM.

The sudden death of M. K. Barnum at Baltimore, Md., occurred on October 26. A scholarly, gifted, diligent mechanician of the highest order, he was among the very best types of railroad man. A graduate of Syracuse University he entered railroad service as an apprentice machinist in the shops of the New York, Lake Erie & Western in 1884, and during the last thirty-five years he has occupied nearly every position in the mechanical department of railways, particularly in the leading railroads in the Middle States, and in some of the Western States. Since 1913 he was attached to the Baltimore & Ohio as superintendent of motor power for four years, and in 1917 a position was created for his special qualifications as adviser in the conservation of material. He was a model of tireless industry, and was greatly esteemed on account of his genial, kindly disposition.

BULLETINS, CATALOGS, ETC.

"National" Bulletin.

No. 7, "National" Bulletin, issued by the National Tube Company, Pittsburgh, Pa., is more than usually interesting, from the fact that it furnishes detailed descriptions of the process of manufacturing the company's fine products. As is well known, the career of the National Tube Company is one that has been marked by a long series of accomplishments through which the steel tube industry as a whole has been benefited substantially, and through which "National" Pipe has become a recognized standard among wrought tubular products. Much of the success must be credited to the marked improvement in the steel industry, but this has been supplemented by the introduction of a mechanical process of roll-knobbling the steel, known as the spellerizing process, consisting of a local lateral working of the hot bloom which renders the metal more uniformly dense when there is any tendency to physical irregularity in this respect. A scale removing process has also been successfully worked out by putting the pipe put through a set of sizing rolls before passing to a cooling table, the finished pipe retaining the desirable thin, tightly-adhering film of blue oxide which gives a certain amount of protection to the pipe without possessing the disadvantage of heavy welding-scale. While it would seem that there is nothing further to be desired, the company is proceeding with further experiments looking toward perfection.

Staybolts.

The overcoming of the lesser difficulties in the operations of drilling, reaming and taper tapping is minutely treated in the latest issue of the *Bi-Monthly Digest*, published by the Flannery Bolt Company, Pittsburgh, Pa. The data is of real value because it is the result of following up complaints and making examinations in faulty material that is not infrequently supposed to be the company's product, but is found to be otherwise, the material coming from some other manufacturers. Experience has given the experts that degree of justifiable assurance upon which the reputation of the enterprising company has been built. The October issue is well worthy of a careful perusal. Copies may be had on application.

Resistance of Passenger Trains.

A series of tests to determine the resistance of passenger trains at all speeds up to seventy miles per hour, and for average car weights have been completed by the Railway Department of the Engineering Experiment station of the University of Illinois. Of the 240 cars composing the 28 trains tested, 178 had six-

wheel trucks and 62 had four-wheel trucks.

These tests were made on the lines of Illinois Central Railroad by Professor E. C. Schmidt and H. H. Dunn upon well constructed and well maintained main line track laid almost entirely with 85-pound or 90-pound rail and ballasted with broken stone. From the results, which are given in Bulletin No. 110 of the Engineering Experiment Station, a table has been prepared showing the probable average value of resistance for passenger trains composed of cars weighing from thirty to seventy tons and operating at speeds ranging from five to seventy-five miles per hour. Copies of Bulletin No. 110 may be had without charge by addressing the Engineering Experiment Station, Urbana, Ill.

The Return of the Railroads.

Thomas DeWitt Cuyler, chairman of the Association of Railway Executives, delivered an address last month at Philadelphia, outlining at some length how the railroads should be returned. The matter now appears in pamphlet form. Mr. Cuyler believes that the railroads should have the right to pool their traffic and to have joint terminal facilities for freight and passenger service. Under watchful Federal control for the protection of the public latitude should be given the roads to enable them to meet the requirements of the country. Consolidation should be permitted when it is clearly in the interests of the roads and the public.

Electric Arc Welding.

The Canadian Westinghouse Company, Limited, Hamilton, present a useful publication of 48 pages, describing in detail the application of electric arc welding. During the last few years, they point out, an unusually rapid advance has been made in the process and it has now become recognized as an art very essential to a number of industries. The field of electric arc welding is unlimited and practically every industry employing iron and steel or other alloys, can utilize it to advantage. All of which makes the description contained in the present booklet of value. There are copious illustrations, which add to the effectiveness of the treatise.

Autogenous Welding.

The Davis-Bourneville Company, Jersey City, N. J., has established a school of instruction in welding at their works in Jersey City. The terms of instruction as specified in an illuminated circular are such that they should attract a large class of students who desire to learn oxy-acetylene welding and cutting. A review of the system with illustrations of the appliances are shown in the circular, copies of which may be had on application.

Profit Sharing.

The *New York Times* published an elaborate essay by M. L. Schiff on "Profit-Sharing," and the matter now appears in pamphlet form. It is surprising how many clever writers have given their attention to this subject, and not one has ventured to touch the subject of loss sharing. It would not be a difficult task to examine statistics and find a monumental record of disasters, and while the creditors may be the chief loss sharers, no essayist cares to mention a word of sympathy or a plan of assisting the adventurer who may have been a thrifty and an accomplished man impelled by a praiseworthy endeavor to go beyond his depth; there is no rescuing hand held out to him. He must walk his dark way alone, while the hat is passed around for played out play actors, and penniless parasites, who did not know a rainy day until they were in it.

Railway and Locomotive Engineering

A Practical Journal of Motive Power, Rolling Stock and Appliances

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Electric Locomotives for the C., M. & St. P. Railway

The 3,000-volt direct-current electrification of the Chicago, Milwaukee & St. Paul Ry. is the most extensive railway electrification that has, thus far, been developed and, as such, has attracted world-wide attention. It covers a distance of about 850 miles from Harlowton, Montana, to Seattle and Tacoma, crossing the Big Belt, Rocky, Bitter Root and Cascade ranges. In crossing these four mountain ranges there are several grades of one per cent. or more, the most difficult being the 21 miles of two per cent between Piedmont and Donald and the longest the 49 miles of one per cent. grade on the west slope of the Belt mountains. The curvature is necessarily heavy, the maximum being ten degrees.

About 440 miles of this line from Harlowton, Montana, to Avery, Idaho, have been under electric operation for about four years, and now the balance is to be put into service.

The current for the operation of the line is furnished by the Montana Power Co., which has now completed the development of fourteen hydro-electric plants with an aggregate capacity of 171,530 kilowatts, of which the largest is the plant at the Great Falls of the Missouri River of 60,000 kilowatts. To this must be added a 40,000 kilowatt plant at Holter on the Missouri River, which is in course of construction, and four steam plants having a total capacity of 5,920 kilowatts.

The transmission lines from these plants form a network covering a large part of Montana, and which tap into the railway system at seven different points, where the power is most needed. So that, with this completely interconnected transmission system, each sub-station may be fed from either direction, and also at the tie-in points from a third source of power, by which the reliability of the source of power is insured.

The portion of the line first electrified was operated by 300-ton locomotives with geared motors having a ratio of reduction of 4.56 to one. The General Electric Co. are just completing an order for a number of gearless locomotives, which will be used in both passenger and freight service. These engines are of the following general dimensions, weights and capacity.

CHICAGO, MILWAUKEE AND ST PAUL 3,000 V. D. C. ELECTRIFICATION TRAIN NO. 16 DESCENDING 2 PER CENT GRADE.

Length inside knuckles	76 ft.
Length over cab	68 ft.
Total wheel base	67 ft.
Rigid wheel base	13 ft. 11 in.
Diameter driving wheels	44 in.
Diameter guiding wheels	36 in.

Weight of electrical equipment, 235,000 lbs.
Weight of mechanical equipment, 295,000 lbs.
Weight of complete locomotive, 530,000 lbs.
Weight on drivers............458,000 lbs.
Weight on guiding axle.......36,000 lbs.
Weight on each driving axle..38,166 lbs.
Number of motors..................12
One hour rating ....3,240 H.P.
Continuous rating ....2,760 H.P.
Tractive effort, one hour rating, 46,000 lbs.
Tractive effort on 2 per cent. ruling grade with 960-ton train.....56,500 lbs.
Coefficient of adhesion on ruling grade ....12.3 per cent.
Starting tractive effort, 25 per cent. coefficient of adhesion......115,000 lbs.
Rate of acceleration starting on 2 per cent. grade, 0.48 miles per hour per second

It will be seen from this that the engines rank well to the fore in a comparison with any steam locomotives. The starting tractive effort of 115,000 lbs. with a continuous rating of from 42,000 to 56,500 lbs. reaches the highest of steam locomotive practice.

The locomotive is designed to haul a 12-car passenger train, weighing 960 tons, up a 2 per cent. grade at a speed of 25 miles per hour. This requires the tractive effort of 56,500 lbs. given in the tabulation above. But even this involves so low a coefficient of adhesion (12.3 per cent.) that there is no liability of slipping the wheels.

The change from the geared to the gearless type has resulted in an increase of efficiency. A diagram of efficiency rating running from 25 to 65 miles per hour, shows that up to about 32 miles per hour the geared locomotive is the more efficient machine of the two. At higher speeds it is the gearless that is the more efficient. At a speed of 25 miles per hour the efficiency of the geared engine is about 88.5 per cent. This rises to 90 per cent. at 30 miles per hour, remains constant to about 32 miles per hour and then falls off on a nearly straight line to 70 per cent. at 65 miles per hour. On the other hand, the curve of the gearless motor starts at about 86 per cent. efficiency at 25 miles per hour, rises on an easy curve to nearly 92 per cent. efficiency at about 38 miles per hour and then runs straight and without change out to 65 miles an hour. So that at this high speed there is a marked difference between the two.

TESTS OF GEARLESS LOCOMOTIVE. STEAM AND ELECTRIC LOCOMOTIVES DURING REGENERATIVE BRAKING TEST.

The control equipment for these locomotives is similar in most respects to that used on the geared locomotives. Modifications were, of course, necessary to comply with the different arrangements of motors. Advantage is taken of a new method of connections by means of which four of the main locomotive motors are utilized to furnish exciting current during regeneration, thus reducing the size of the motor-generator set used for control, accessories and train lighting. Thus an appreciable reduction in the weight of control equipment is obtained, at the same time providing for effective regenerative electric braking on the down grades. The motor-generator set furnishes control current for operating the contactors and for charging an 80-volt storage battery which supplies lights and power for the accessory apparatus. The battery is, in general, similar to those used on passenger coaches. The master controller is constructed in three sections, arranged for both motoring and regenerating, all of the cylinders being suitably interlocked to prevent incorrect manipulation.

The motor is bipolar, the two fields being supported upon the truck springs with full freedom for the vertical play of the armature between the pole faces. The illustration of the end elevation of the gearless locomotive shows its outline with a sectional view of four of the motors indicating the location of the armatures and the magnetic section. For full speed operation, the twelve motors are connected, three in series, with 1,000 volts per commutator. Control connections are also provided for operating four, six or twelve motors in series. Additional speed variation is obtained by tapping the motor fields in all combinations. Cooling air for each pair of motors is supplied by a small motor-driven blower. This arrangement avoids the heavy losses in when a single large blower is used.

3000 VOLT GEARLESS PASSENGER LOCOMOTIVE, CHICAGO, MILWAUKEE AND ST. PAUL RAILWAY.

In designing the new locomotives a distinct change was made in the running gear. The original engines consisted of two units, each comprising three trucks. There was a four-wheeled guiding truck which was located at the end of the machine, followed by two other four-wheeled motor trucks, to which was added another unit arranged in the reverse order. The arrangement of the new engine also consists of three trucks at each end. The guiding truck is two-wheeled, and is followed by a four-wheeled and then by an eight-wheeled truck. Then comes the same arrangement in reverse order. These trucks are so coupled together that any lateral oscillation that may be caused by inequalities of the track are broken up and the machine given a very easy motion, so that the riding qualities at high speed are remarkably good, as demonstrated on the test track at Erie, Penna., which has also demonstrated that an equally satisfactory performance can be obtained at higher speeds.

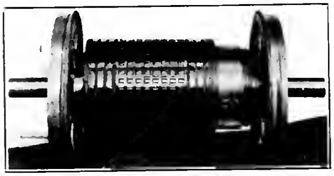
The cab is in three sections. The weight of the end section is so supported on the front and rear trucks that any lateral thrust or kick of the leading or trailing wheel against the track is cushioned by the movement of the cab, which increases the weight bearing down on the wheels at the point where the thrust occurs, and automatically reacts to prevent any distortion of the track. This assists in securing the fine riding qualities already referred to.

In the center cab there is an oil-fired boiler, with its accessories, for heating passenger trains. The accessories consist of tanks for oil and water, circulating pumps and a motor-driven blower for furnishing forced draft. This center cab is so arranged that it can be lifted off from the trucks in case it becomes necessary to make repairs upon the boiler.

The current is collected from the overhead wires by means of a slider pantograph, one of which is placed on the cab at each end of the engine. There are two sliding contacts on the pantograph, so that there are four on the slider with a double trolley. This, with the flexible twin trolley construction, enables the locomotive to collect ample current at any speed, running as high as 2,000 amperes at 60 miles an hour, and that without any appreciable arcing at the contact points.

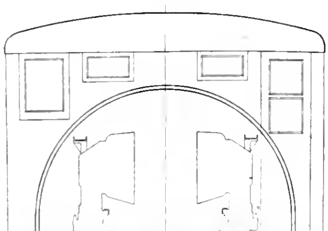
Only one pantograph is used at a time, the second being lowered and held in reserve.

The movement and adjustment of the pantograph is controlled by means of an air valve. To raise the pantograph, air from the main reservoir is admitted to a pair of cylinders. The pistons of these cylinders energize powerful springs, which, in turn, raise the collector and, at the same time, regulate the pressure against the trolley wire. The raising springs are energized at all times while the collector is in use, by maintaining air pressure in the cylinders. To lower the pantograph, air is exhausted from the cylinders, thus de-energizing the springs. The pantograph will then drop to its minimum collapsed height. The range of action of the trolley is between 17 ft. and 25 ft. above the rail.



DRIVING WHEELS AND G E-100 ARMATURE

One of the prominent features of the system is the use of regenerative braking for the control of trains on a descending grade. This feature adds very materially to the safety of operation by supplying a second braking system in addition to the air brakes. It provides increased economy of operation by reducing wheel, track and brakeshoe wear. It permits faster speeds down grades, due to the better ability of definitely controlling the locomotive, which is difficult at best with the air brakes. It also adds materially to the comfort of the passengers, because of the smoother operation down grades. And this is attained by means of very simple and reliable additions to the equipment required for motor running.



END ELEVATION OF GEARLESS LOCOMOTIVE.

With the simple direct current motor adopted for these locomotives, their operation as motors or generators depends upon whether the voltage of the trolley system at the locomotive is above or below the voltage at the motor terminals. When the locomotive is motoring, the voltage at the motor terminals is lower than the trolley potential, and power flows into the locomotive. When the locomotive descends a grade, and is braking, the engineer effects an increase in the voltage across the motor terminals so that power flows from the locomotive into the transmission system. The generation of this returned energy reacts on the locomotive so as to cause retardation or braking, besides effecting an economy by returning power to the line. So these locomotives which are descending grades, by revolving their motors as generators, deliver power to any other ascending locomotive. In this way a conservation of energy is effected in that a portion of the power required for raising the locomotives to the top of the divide is later returned in the descent.

In train braking there is no external evidence of this internal resistance of the locomotive other than the reduced or controlled speed on a descending grade. A rather spectacular demonstration of the possibilities was recently given to a gathering of railway officials on the experimental track at Erie, Penna.

Two heavy steam freight locomotives were attached to a single electric locomotive, and the engineers of the steam locomotives were instructed to push the electric locomotive, which was placed in regenerating position, at a speed of from 25 to 28 miles per hour. This was done, and their exhausts told the story of long cutoffs and heavy work Meanwhile the generated current was poured back into the line to such an extent that, for a time, the major portion of the General Electric shop at Erie was run by this current. Probably the first time on record that the draw-bar pull of a passing locomotive was used to drive the machinery of a shop alongside the track. It is roughly estimated that about 40 per cent. of the draw-bar horsepower of these two steam locomotives was converted into useful work in driving the shop tools.

Another demonstration of the power of the electric locomotive was made at the same time in a tug-of-war contest. The two steam engines were coupled to the electric and allowed to acquire a speed of from three to four miles an hour, when the current was thrown on to the electric. The two were stopped and slowly pushed backward. This merely showed that in this case the electric locomotive was more powerful and had a greater adhesive weight than the combined weight on drivers of the other two. But as the two were large and heavy engines, the mere fact of ability to stop them and push them against themselves made an impressive sight.

The Burning of Tubes

Curious Cases of Combustion in Boiler Flues

Occasionally the impossible seems to happen in the mechanical and chemical world and not the least of these impossible paradoxes is the burning of tubes by a seemingly spontaneous combusiton, which is reported from time to time.

Here are three illustrations of what is meant:

A certain master mechanic had a lot of badly scaled locomotive boiler tubes. He had found that the scale was of such a nature that it could be cleaned off by the application of heat. So he thought that he would make one grand job of it. He had them put in a pile and built a fire of oak ties beneath them. The fire was not hot enough to burn the tubes, but quite sufficient to remove the scale according to previous experiences. He saw the fire lighted and went to his office. he had hardly taken his seat at his desk when a man rushed in and said that the tubes were melting. He went out and found that the fire was burning with ordinary brightness and not with any great intensity, but that, when he looked into the tubes, he looked into a glowing furnace at a white heat. The oak fire was pulled, but the tubes continued to glow and melt until they were quite destroyed.

The other case was that of a tug boat in New York harbor where the phenomena and conditions were very similar to those obtaining in the next case quoted.

The boiler had been emptied and the tubes were melted. The exact time and the details of the conditions are not available, but the destructive action in all of its essential particulars was a repetition of the locomotive which will be given as the third instance. The boiler had been emptied and the fire drawn. Then when the attendants went to do some work upon it, it was found that the tubes were at a white heat and melting. The time required for this destructive action to take place is not known, but these are the essential particulars.

The third case is that of a locomotive, the results of which are given in the accompanying engraving.

The story is that the engine was in an accident and was side-swiped. The running board, cab, brackets and main reservoir were torn off from the left side, the guide yoke bent and other minor damages inflicted. Some of the studs holding the running board were also torn out of the boiler, which caused a loss of steam and water. This happened about 12:30 at night. The fire was knocked out of the engine as quickly as possible, the dampers closed and the night roundhouse foreman notified.

PHOTOGRAPHIC REPRODUCTION OF AN UNUSUAL COMBUSTION OF BOILER FLUES.

At 2 o'clock in the morning the roundhouse foreman went out to the yard and, finding the fire out of the engine, ordered it hauled into the roundhouse. This was done at about 3:30, when it was set in over the cinder pit. Shortly afterwards one of the laborers at the cinder pit came to the foreman and notified him that the headlight had exploded. He went to the engine at once and found the front red hot, which was the cause of the explosion of the headlight. He then took off the small front and found everything red hot inside. The next step was to spark the front end and remove the brick arch, but that did not seem to relieve the heat. To help in the cooling off a plate was put over the top of the stack, and the firebox door opened.

At 6 o'clock in the morning the front end was still very hot, though there was no fire in the firebox or ashpan and the brick arch had been removed. The men were afraid to put water in the front end because of the uncertainty as to what would happen. At noon, or about twelve hours after the accident and ten hours after the fire had been hauled the flues were still red hot in the engine. A part of the tube sheet had been melted as well as the ends of many of the tubes, and the metal had run down into a puddle in the front end.

When the engine was critically examined after it had cooled off, it was found that the greatest destruction was wrought by the heat, just back of the injector check where a large number of tubes were melted.

This is the second occurrence of this kind that happened on the same road within a space of three years.

The illustrations show the condition of the tubes after the removal of the front tube sheet and of the tubes in the interior of the boiler.

Before attempting to explain this curious phenomenon, another incident may be related which may throw some light on the subject. A number of years ago a certain stationary boiler plant was burning wood and shavings in boilers of the locomotive type. Nearby there was an old charcoal shed where, for very many years, charcoal had been loaded into cars for the old Copake iron furnaces. The ground all about was covered to a depth of six or eight inches with charcoal dust. The owner of the boiler plant thought that that charcoal dust ought to make good fuel for his boilers. So several wagon loads were hauled and thrown into the fuel room and mixed with the shavings that were being burned.

The fireman began using the mixture at about 3 in the afternoon. The charcoal acted as a deadener at once. The effect was almost as though ashes had been thrown in over the fuel bed. The steam pressure began falling immediately and by 4 o'clock the plant was dead and the employes had all gone home. The charcoal had simply put the fires out and a shutdown followed because of a lack of steam. The engineer left everything snug for the night. Dampers all closed and not a spark of fire visible in the fire-

box, expecting to return early in the morning to clean out.

When he did so he was accosted by the night watchman with the inquiry as to what had been done with the fire. He said that, at about 1 o'clock, he had been called to the fireroom by the opening of the safety valves, and had found the hottest fire that he had ever seen in the firebox, and had been obliged to run the engine and shop all night in order to keep water in the boilers, as the pumps were power driven.

Of course, in this case the engineer was mistaken in thinking that the fire was out. But the gentle draft permitted by the possible leakage of air through the dampers was just sufficient to bring the whole practically solid bed of charcoal to a glow. This was accomplished very slowly and gradually as was the subsequent rise of steam pressure as about nine hours elapsed between the shutting down of the plant and the opening of the safety valves. It is merely to be taken as a demonstration of the fact that finely divided charcoal (carbon) can be made to glow throughout a whole mass, in quiet or slowly moving air, provided a temperature above the ignition point exists at some place.

Then let us bear in mind that the rusting of iron, which is the formation of a combination of oxygen and iron, is a process exactly like that of the formation of a similar combination of carbon and oxygen in the burning of coal. That there is a similar development of heat that is ordinarily inappreciable because of the slowness of the chemical action, but which becomes very evident when an iron wire is burned in an atmosphere of oxygen, a true combustion that can be started by raising the wire to the ignition point, which is at about 1,250° Fahr.

The experiment of producing the same effect at atmospheric temperature is also a familiar one. That is, "when very finely-divided iron (which has been protected from oxidation) is thrown into the air, it burns brilliantly, producing a shower of sparks. Under such circumstances a large number of molecules of iron and oxygen are in contact at the same time, and as a result of the oxidation of so many molecules at once raises the temperature of the particles of iron; this rise in temperature accelerates the oxidation, which finally becomes so rapid as to cause evolution of light."

A somewhat similar phenomenon is produced in the well-known reactions of thermit welding, where oxide of iron is decomposed by heat in the presence of aluminum. The decomposition of the oxide of iron sets free an excess of oxygen for which the aluminum has a greater affinity at a high temperature (2,000° Fahr.) than the iron, resulting in a rapid development of a high temperature.

Now we know that, in blast-furnace work, the ore which is an oxide of iron is decomposed near the top of the furnace at a temperature of from 400° to 600° Fahr., so that the point of possible decomposition is known. We also know that the ignition point of carbon varies from less than 600° to 1,300° Fahr., dependent upon its form and the character of the substance from which it was derived. These facts should be borne in mind in the following hypothetical argument.

Unfortunately we have no data regarding the exact condition of the tubes in the boiler under consideration, or of having been heated to a high temperature by its contact with the arch. As the water was out of the boiler, and the tubes were fairly well protected against a loss of heat, the air was not appreciably cooled in its passage through the tubes and the latter were heated. This heated air coming in contact with the iron rust, or oxide of iron, broke it down, and, by so doing, released an excess of oxygen into the air. This promptly, under the influence of the heat, proceeded to form a new compound with the available carbon, which developed a still further increase of temperature, producing more oxygen,

ANOTHER VIEW OF THE EFFECTS OF SPONTANEOUS COMBUSTION OF BOILER FLUES.

those in the pile over the fire, and a supposititious case must be built up in order to arrive at a possible explanation of the phenomenon before us.

It seems fair to assume that the outside or water side of the tubes was covered with scale, because it is known that the boiler was using a scale-forming water. This insures a certain amount of insulation against radiation of heat from the outer surface of the tubes both by the coating of scale and the quiet air confined in the boiler. It is also assumed that the interior or fire side of the tubes was coated with rust and soot, and that there were some unburned cinders lying in the bottom; though of this there is no direct evidence. It is merely essential to the construction of the case.

Finally we know that there was a brick arch which was hot at the time of the accident and that the ashpan dampers were closed when the heat was developed in the boiler.

Then, with a little air leaking through the dampers, there was a gentle and quite imperceptible movement of hot air through the tubes to the stack, the air which was immediately available for combustion and which was thus fed without the need of a supply of oxygen from the air. It is merely a simple cycle and quite within the bounds of possibility, and is offered as an explanation of an occurrence that seemed uncanny because it fell outside the range of our ordinary every-day experience. It might have happened from that cause, and the reason it does not happen oftener is that the necessary conditions are not present. There must be an empty boiler so that the tubes and contained air may not be cooled by the surrounding water. The contained air must be nearly stagnant. There must be a source of heat of such a character as not to create a draft and the outer air must be excluded. And there must be present a sufficient quantity of the oxide of iron to supply the needed excess of oxygen, and there must be the carbon to unite with it when it is set free. All these unusual conditions are necessary to the execution of the hypothesis, but when they do exist, there is no reason why the unusual phenomenon here chronicled should not manifest itself.

Locomotive Designing*

Features Involved in Locomotives Using Coal for Fuel

The paper proposes to briefly outline the principal features involved in the correct design of locomotives using coal for fuel. Fuel combustion in a locomotive firebox is seldom, if ever, perfect, and the proportions must be made to agree with the known averages. No other branch of industry is subject to the physical and "personal" extremes found in railway mechanical operation. The first thing, therefore, is the consideration of evaporating value in fuel, and this value is taken at figures much below the maximum obtainable under perfect conditions. With the various grades of coal the following are suggested as averages useful in locomotive design; they are expressed as pounds of water evaporated per pound of coal:

	Per cent	lbs.
Semi-Bituminous	100	7
Bituminous, good grades	97	6.75
Bituminous, average	93	6.5
Anthracite, average	93	6.5
Bituminous, low grade	86	6
Sub. Bituminous or Lignite	72	5
Brown Lignite	61	4.25

Grates for burning coal fuel should be proportioned so that the number of pounds burned per hour on a square foot of grate should not exceed 200 in extreme cases of narrow and deep fireboxes and range downward to 60 lbs. for anthracite culm and brown lignite. In modern engines coal rates above 120 pounds per square foot per hour are not recommended. It is, therefore, wise to set this figure as a limit, although many of our older locomotives are operating (without economy) on much higher rates.

The lighter grades of fuel (slack coals) should be burned at slower rates than the heavier sorts, for the obvious reason of keeping down stack losses. Lignites require slow rates, not only on account of lightness, but also because of their high ash content and consequent tendency to clog the grates. Anthracite, although of comparatively high heating value, naturally burns slowly because of its lack of volatiles. Its consumption on grates is also hampered by high ash content. Slow rates are, therefore, necessary for this class of fuel.

A summary of recommended rates for coal consumption per square foot of grate area per hour can be stated as follows:

Bituminous coals...........100 to 120 lbs.
Anthracite and lignites...... 60 to 80 lbs.

These rates must be used with judgment and preferably graded by the exact analysis.

In designing a locomotive for coal fuel, the first consideration is the boiler horsepower and the rate of evaporation. Various methods are in use for calculating these proportions, and those given in this paper are the simplest for average use. A rather exhaustive discussion on locomotive boiler proportions has been written by F. J. Cole, of the American Locomotive Company, and quite generally distributed amongst the railway mechanical officials. Its exact results will in most cases vary but little from those obtained by the empirical method suggested in this paper.

Locomotive boilers will evaporate about 12 pounds of water for every square foot of evaporative heating surface. Saturated steam locomotives will develop one horsepower on about 28 pounds of steam. Superheated steam locomotives showing an economy of 25 per cent. over similar saturated engines will develop one horsepower on about 21 pounds of steam.

Boiler horsepower is the capacity for the production of power in a unit of time, the horsepower hour. Cylinder horsepower is the capacity of the locomotive cylinder to produce power at a specific rate; also the horsepower hour. Of late years there has been considerable discuscion on the proper proportioning of cylinder and boiler to give equivalent horsepower. This proportion is of vital importance, but the design should not aim for the so-called 100 per cent. boiler on arbitrary rules of maximum cylinder horsepower. Variations of service cause variation in cylinder and boiler proportions, and frequently a close analysis of working conditions will reveal a proper proportion where the 100 per cent. dule apparently fails.

The prime factor in the cylinder horsepower is the piston speed, and numerous well authenticated tests have demonstrated the occurrence of maximum horsepower at piston speeds approximately 1,000 feet per minute. This factor, worked backward through the piston stroke and driving wheel diameter, really controls the operating speed of the locomotive. Take for example a passenger engine having 28-inch stroke and 79-inch diameter drivers; piston speed of 1,000 feet per minute represents in this case an engine speed of 50 miles per hour. Such an engine must have its boiler proportioned as nearly as possible to suit the maximum horsepower, this maximum being produced under normal operating conditions.

Maximum boilers can only be applied to engines having multiple carrying wheels—leading and trailing trucks—and to those not restricted by close weight limitations. This is the real reason for the adoption of trailing trucks on modern engines for road service. Additional boiler capacity and grate area can thus be carried within the restrictions of individual axle loading and without unduly increasing weight on drivers. It follows also that the proportion of cylinder to boiler is actually contained in the factor of adhesion; this really governing the proportions of the boiler rather than any arbitrary percentage based on an arbitrary cylinder horsepower.

Careful locomotive designers will analyze the conditions of service and will set cylinder horsepower requirements at service speed rather than at a maximum obtainable at 1,000 feet piston speed.

Calculation of cylinder horsepower at any given speed can be made by the simple formula $H.\ P. = \frac{T \times N}{375}$.

In this combination T represents pounds of tractive power at a given speed and N represents the speed in miles per hour at which T is developed. Tractive power at speeds other than "drag speed" must be calculated by using in the accepted formula a reduced mean effective pressure readily obtainable from the tabulated results of indicator tests. Such reductions are set forth by the curve (Fig. 1) accompanying this paper, which shows "mean effective" pressure factors used by the Baldwin Locomotive Works; these set forth in their relation to piston speed. As our horsepower calculations make it necessary to transform piston speeds into engine speeds of miles per hour, or vice versa, there is also submitted with this paper a chart of curves (Fig. 2) showing the various piston speeds brought about by stroke and wheel combinations at engine speeds of 10 miles per hour. In the use of these curves it is only necessary to know the wheel diameter and the piston stroke; piston speed may be read direct and multiplied by a factor representing the engine speed in miles per hour. For example: 28-inch stroke combined with 51-inch diameter wheel gives 306 feet per minute piston speed at 10 miles per hour.

In the case of the switch engine before discussed a speed of 15 miles per hour will give 1.5 times 306 or 459 feet per minute piston speed. Reading this against the mean effective pressure chart—saturated steam line—we find that it represents 64 per cent., which factor must be substituted in the tractive power formula for the 85 per cent. usually taken as maximum.

To further follow our study for the design of a switching engine with 51-inch drivers and 28-inch piston stroke, we will assume that an engine of this character is to be designed with cylinders 21 inches in diameter, working at 190 lbs. pressure

*Abstract of a paper read before Cincinnati Railway Club by W. A. Austin of the Baldwin Locomotive Works.

with superheated steam, and that the boiler is to be designed to provide proper horsepower for an average engine speed of 12 miles per hour—also that the fuel to be used is of average bituminous variety equivalent to 93 per cent. standard; this fuel giving average evaporation of 6½ lbs. water per pound of fuel.

Piston speed at 12 miles an hour is 306 × 1.2, or 368 ft. per minute. For this piston speed the mean effective pressure will be 74 per cent. and the tractive power calculation will be:

$$\frac{21 \times 21 \times 28 \times 190 \times .74}{51} = 34{,}100 \text{ lbs.}$$

Cylinder horsepower is:

$$\frac{34{,}100 \times 12}{375} = 1{,}090$$

To design a boiler of equal horsepower produced with superheated steam we must secure evaporation equal to 1,090 times 21; 21 pounds representing the amount of superheated steam necessary to produce one horsepower. Therefore, 1,090 × 21 = 22,890 lbs. of steam to be produced per hour. To evaporate this quantity at an average of 12 lbs. per square foot of heating surface, our calculation will be:

$$\frac{22{,}890}{12} = 1{,}900$$

Thus to have boiler horsepower exactly equal to cylinder horsepower, we require 1,900 square feet of evaporation heating surface.

The calculation for grate area is based on 6½ lbs. evaporation for average bituminous coal, and the amount of coal to be burned per hour is therefore obtained by dividing 22,890 by 6½, the result of which is 3,520 lbs. of coal. This amount divided by a coal rate of 110 lbs. per square foot of grate area (average bituminous rate), establishes a necessary grate area of 32 square feet. If desired, these ratios can be carried to the amount of coal per horsepower hour by dividing 3,520 by 1,090, this calculation resulting in practically 3.25 lbs. the usually accepted rate for engines using superheated steam.

These figures used in establishing proportions for a 21 in. x 28 in. switch engine are actually the ones that can be applied to the United States Government standard 0-6-0 switcher, a very carefully designed engine and one that will no doubt give satisfactory service. The exact heating surface used for this engine is 1,891 square feet, or nine feet less than calculated. The actual grate area is 33.2 square feet, or 1.2 square feet more than calculated. These dimensions result in a boiler horsepower of 1,080 and a coal rate of 106 lbs. per square foot of grate area. Criticism may be directed to the limitation of 12 miles per hour speed placed upon the design of switching engine just considered, and quite generally to other switchers that on first sight appear to be lacking in boiler capacity. Our answer is, that switching service very seldom calls for full power excepting at "drap speed." Service is always intermittent, and even at the higher speeds it calls for no serious power output from the boiler for any great period of time.

As stated before, all calculations of this character are dependent on the weight allowed for the design, and the boiler proportions so calculated must frequently be modified to come within this limitation. This is within the province of an expert in locomotive design and weight estimation, and not within the scope of this paper. It is needless to say that road engines having service which calls for long sustained power output (fast passenger engines especially) should have a boiler as large as possible within the limitation of weight.

Having now established the general proportions of boilers and the establishment of grate area for burning the various grades of coal, there naturally follows an examination of the details that are auxiliary to proper combustion. The first consideration is the grate itself. For ordinary bituminous coals the "finger bar" grate is recommended. For the poorer grades of bituminous coal the rocking frame bar with auxiliary rocker, commonly known as the "Illinois coal grate," gives the best results. For anthracite and lignite a "table grate" should be used.

In practically all types of grate bars the air openings should be about ¾ in. wide; although with some grades of sub-bituminous coals and with anthracite culm an opening of sub-bituminous coals and with anthracite culm an opening of ⅜ in. in width is found necessary to prevent undue loss into the ash pan. Fingers and grids between the air openings should be made as light as is consistent with strength, so that the percentage of air opening in the total area of the grate will be maintained at a maximum. The dimensions generally adopted are from ⅝ in. to 1 in. width for their grids and fingers. Rocking bars should be spaced at approximately 10-inch centers, and should allow a movement through an angle of 45 degrees, with a clear opening of about 4 ins. between bars at the maximum angle of movement. The use of "dump grates" should be avoided unless the character of ash and clinker demands them. They are usually producers of "dead" grate area. Bars properly designed for movement and opening will allow all room necessary for cleaning. Grates should be made in rocking sections not too large for easy operation, and the following rules usually insure this feature:

Narrow firebox grates up to 79 ins. long—one section. Narrow firebox grates over 79 ins. long—two sections. Wide firebox grates under 98 ins. wide—four sections. Wide firebox grates 98 ins. wide and over—six sections.

The length of wide firebox grates is not given as a factor because grates of these widths are usually of sufficient length to make two fore-and-aft sections necessary. Exception is sometimes met in the case of switching engines having short and wide fireboxes overhanging the rear drivers. These can be racked in two sections.

Smokestacks are designed with considerable variation according to limiting conditions, and for ordinary sizes of locomotives are from 14 to 21 ins. in diameter at the "choke." A taper of 1 in. in diameter for every 12 ins. of height is recommended above the "choke" diameter. One locomotive builder gives recommendations for "choke diameters" based on boiler horsepower, approximately as stated below:

14 ins.	diameter	for	1,200	boiler	h.p.
15 "	"	"	1,300	"	"
16 "	"	"	1,500	"	"
17 "	"	"	1,800	"	"
18 "	"	"	2,300	"	"
19 "	"	"	2,800	"	"
20 "	"	"	3,300	"	"
21 "	"	"	4,000	"	"

In actual practice, the diameter of the smoke box, height of stack above exhaust tip, size of exhaust tip and other varying factors have much to do with the diameter selected. The designer should be sure that his exhaust will "fill the stack" and for this purpose a diagram can be constructed with the angle of exhaust steam discharge set at 2 ins. increase in diameter for every 7½ ins. of height above the exhaust tip. This rule is, of course, strictly empirical, but its general results have been borne out by numerous experiments.

In the design of ash pans, it is well to bear in mind the fact that perfect combustion of coal is only possible with an ample supply of air, as complete transformation of carbon to carbon dioxide requires 12 lbs. of air per pound of pure carbon. Insufficient air supply produces carbon monoxide which liberates only one-third of the amount of heat liberated by the production of carbon dioxide. Furthermore, air supply should be ample so that it may reach the gases above the bed of fuel to insure their complete combustion without the liberation of free carbon in the form of smoke or soot.

It is rather difficult to give the exact amount of air necessary for the complete combustion of coal, as this varies greatly with the rate of combustion and with the composition of the volatile matter; hydrogen requiring about three times as much air as carbon for its complete combustion.

Empirical rules for ash pan design should first state that there should be

no obstructions to interfere with the free admission of air. The area of total unobstructed air openings in the ash pan should never be less than the total internal area of the boiler tubes and flues.

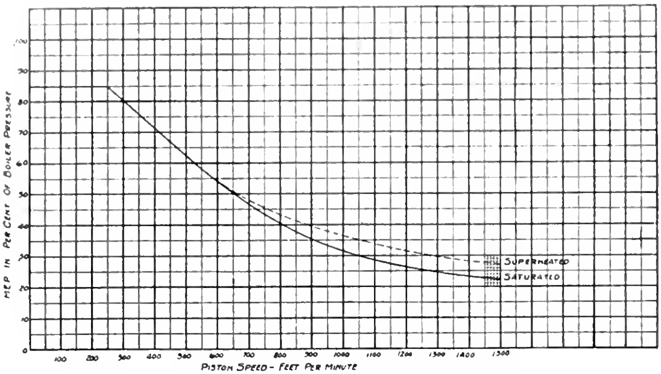


FIG. 1. SHOWING MEAN EFFECTIVE PRESSURE FACTORS.

This area should be increased above the minimum as much as governing restrictions in the design will allow. With low grades of fuel which must be burned at slow rates on the grate, particular attention should be given to air openings. For wide fireboxes the preferable arrangement of air openings is on the sides, directly under the firebox ring, with other auxiliary openings front and back if necessary to obtain the required area.

For narrow fireboxes the arrangement is usually by air openings in the front and back plates. These, as well as all other openings in vertical ash pan plates, should be protected by wire netting and deflectors. Side openings for narrow firebox pans and in some cases for auxiliary air in wide pans, can be made by separating the hopper section from the top section. This arrangement originated with the writer of this paper and has been used with considerable success. Its principle is that of superimposed hoppers, the top one extending some little distance into the lower one, with open space between the two. After all is said and done, the principal rule to follow in ash pan design is to obtain all the air opening possible and never to allow it to be less than the combined "gas-way" of the boiler.

Smoke box drafting appliances have always been the subject of much discussion, and it is not within the scope of this paper to cover detail variations. The principal requirement of any good "front end" is that it be unrestricted for the passage of the gases. Good practice insists that the horizontal area back of the principal deflector be not less than 105 per cent. of the total internal area of the boiler tubes and flues. Rules used by the Baldwin Locomotive Works require ⅓ to ⅗ of the diameter of the smoke box as vertical height under the edge of the main deflector, the latter figure being used in conjunction with deep throated fireboxes. The exhaust tip is set at a distance below the center line of the boiler about equivalent to ⅛ the diameter of the smoke box. Petticoat pipes are usually of diameter equal to ⅔ the diameter of the smokestack and are set with the lower edge of the flare at a distance above the center line of the boiler about equal to one-half the "choke diameter" of the pipe itself. It is preferable to allow variation in the lift of the pipe, at least until such time as experiment has demonstrated the correct location for any particular class of engine under observation. An adjustable apron plate is always necessary, attached to and extending below the edge of the main deflector. Recommendations for netting are subject also to considerable difference of opinion, but a good average for the various fuels can be stated in terms of meshes per inch, as follows:

Front ends equipped for use with

Bituminous coal, good grades........	2½x2½
Bituminous coal, average and poor...	3½x3½
Anthracite, average grade............	3½x3½
Sub-Bituminous and Lignite..........	5 x5

In designing netting screens for ligneous coals it is essential that maximum area be given. The smoke box should be extra long; the netting should run horizontally on the center line of the boiler and extend as far forward as possible before reaching upward in a practically vertical direction to the roof of the smoke box.

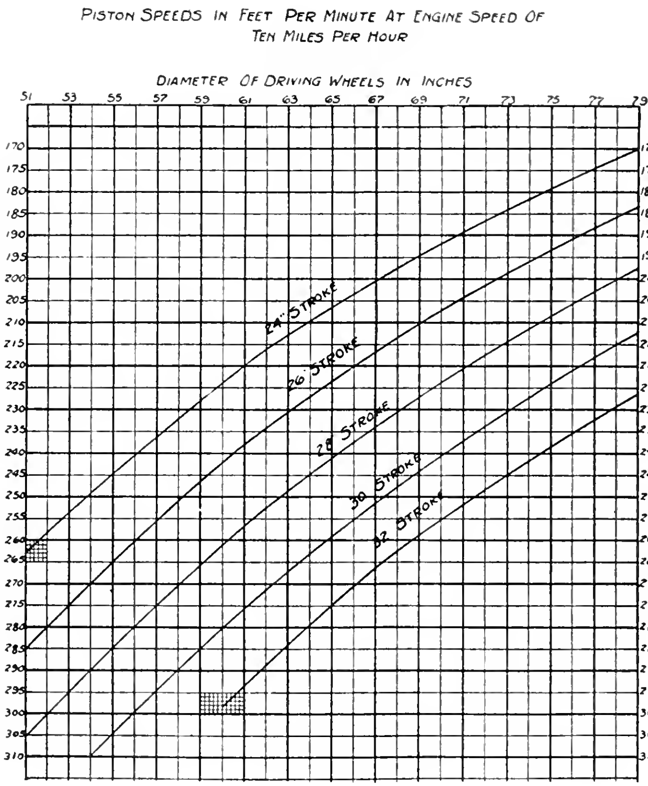


FIG. 2.

It is, of course, essential that the air supplied for combustion be mixed as well as possible with the gases above the fuel bed. For this purpose an arch or wall of firebrick is advisable whenever construction will allow. The feature is an old and well understood practice, the arch supported on studs having been applied to narrow firebox engines over thirty years ago, and being followed closely by the addition of circulating tubes for its support. The brick arch is undoubtedly a valuable adjunct to the locomotive firebox, and of late years it has been much exploited and improved in detail construction, although the principle remains the same. Its use is to baffle the gases, thus giving them more time for combustion. It also protects the flue sheet from direct flame and from blasts of cool air admitted through the fire door. As a means of economy as well as a measure of protection, its application is advisable with the use of all grades of coal fuel.

Auxiliary to the burning of coal in locomotive fireboxes, mention should be made of the present success of mechanical stokers for large power units. It must be understood that the success of the large locomotive is dependent primarily on the amount of fuel that can be supplied to allow its boiler to properly function in producing steam for the cylinders. Take for example the United States government type of heavy 2-10-2 locomotive. Its boiler horsepower is practically 2,700 and if operated at full capacity for one hour, it will require about 9,000 lbs. of bituminous coal. This amount is practically twice the quantity that can be readily fired by hand. As fuel is a direct factor in producing horsepower, it follows that this particular engine, if hand fired, would be capable only of half capacity in its operation if the mechanical stoking device was omitted.

I can speak very highly of the modern (Hanna) stoker manufactured in Cleveland, Ohio, as I have had occasion to observe its operation under very severe conditions. Recent exhaustive tests on a western railroad demonstrated a high degree of economy for this device. Evaporation per pound of Illinois bituminous coal approximated 8 lbs. for the entire test and in some few instances was close to 8 lbs. These results were surprising becaue they were superior to the results usually obtained by best hand firing with a much lighter grade of fuel than that handled by the stoker.

This type of mechanical stoker fulfilled in all details the conditions that should generally be sought in a stoking device applied to a locomotive—these to be classified as follows:

Dependability of operation. Capacity to deliver enough fuel to allow maximum of operation of the locomotive for a long sustained period. Proper preparation of any grade of coal furnished to the locomotive without previous selection or preparation at the coal dock. Mechanical construction of such character as to insure strength and wearing qualities without undue weight. Ease of adjustment for firing the locomotive to best advantage under the variable conditions of service. Ready access to all parts for purposes of emergency, repair and adjustment on the road. Construction of such character as to allow quick change to hand-firing in case of disablement.

The mechanical locomotive stoker of today is past the experimental stage and its use is advisable on all power units whose maximum horsepower requires the firing of more than 5,000 lbs. of coal per hour. It appears that 166,000,000 tons of coal were used in railroad service in 1918 from an entire production of 560,000,000 tons. When it is considered that only about 6 per cent. of the energy in the fuel is converted into useful work at the drawbar, the importance of coal conservation will be appreciated.

A graphic chart showing the distribution of the energy in fuel has been lately published by the Railway Administration, and a summary of this analysis may prove interesting. With the total energy in the fuel considered as 100 per cent., the distribution is as follows:

Loss to ash pan............	4	per cent.
Auxiliary apparatus	6	" "
Radiation losses	5	" "
Loss in exhaust steam......	52	" "
Loss to heat in gases.......	14	" "
Loss to heat in cinders.....	8	" "
Loss in unburned gases and soot	4	" "
Locomotive friction	1	" "
Useful at drawbar	6	" "

Tank Car Maintenance

Importance of Proper Repairs of Friction Draft Gears

At a recent meeting of the Mid-Continent section of the American Society of Mechanical Engineers at Tulsa, Okla., Mr. Paul Bateman, superintendent of the People's Tank Line Co., presented a paper on tank car maintenance in which he first called attention to the lax methods of making friction draft gear repairs.

The gear, as installed, is not at the center of the sills, due to details of construction based on truck clearances and the necessity of keeping the center of gravity of the loaded car as low as possible and there is approximately a 200,000 lb. shock on a 13 in. to 15 in. girder with an eccentricity of about 4 ins. to 6 ins. Any shock above the absorption capacity of the gear is absorbed by a direct blow against the fully-compressed gear which now acts as a rigid block. When wear on the friction elements develops, the end clearance between coupler and buffer block is eliminated and the impact load in excess of the gear capacity is received by the buffer. The gear, as originally installed, gives protection to the car, but when the friction parts wear, more and more of the impact load is directly transmitted to the buffer. As the latter has relatively little resiliency, it is only a question of a short time before it is broken, thus bringing the full load on the gear and thence directly to the sills. The obvious result is that the sills spread and buckle, or else the rivets on the rear draft lugs are sheared, sometimes both. The usual procedure has always been to say, "Oh, let it ride, the sills are all right, we'll fix it sometime." When it is finally released for repairs the first and only thing done is to put on a new buffer and let the wornout gear alone.

If the gear has worn so that the first 1½ in. of travel has become non-effective, there will be left only 1¾ in. of useful travel of the original 3¼ ins., giving a retarding value of only about one-fourth of the capacity of the gear. With the full loading of a moving train, having a possible buffing shock up to 1,000,000 ft-lbs., it is not hard to imagine the effect on the new buffer casting.

This is not an isolated case, but is the usual procedure all over the country, not alone with the refiners, but also with the railroad companies and even some of the private repair shops.

As for truck repairs, let us suppose a loaded car to be in a rapidly-moving train, when an emergency application of the brakes is made.

The braking power is from 70 per cent to 90 per cent of the light weight of the car which, in a 38,000-lb. car of 8,000 gals. capacity, loaded with gasoline, is 30 per cent to 40 per cent of the total weight of the car. The result is that the trucks receive a direct load at the center plate due to the inertia of the entire loaded body of car at whatever speed it is traveling.

It has always seemed inconsistent that one part of the car—the sills, through the coupler—should be used to start the car, and another and much lighter part—the brakes operating on the trucks—should be used to stop it. The writer sees no way, at the present time, to im-

prove the basic principle of this.

The resultant tendency in brake application is to transmit a load to *one* side of the center plate and generate torsional stresses tending to rotate the bolster. This load very naturally comes on only one side of the truck springs, which are intended always to act as a unit. The result is that the springs compress unequally and throw the bolster against the columns with unequal bearing. This causes failure in the columns by tearing the column bolt through the wearing surface of the column. A condition of this kind is usually caused by neglect in allowing nuts of column bolts to become loose, thus permitting the arch bars to spread and allowing excess clearance. Quite frequently the cars, as originally built, have entirely too much clearance.

The material wear of columns and of the column guides on the bolster should be taken up by placing shims on one column or else on the column guide on the bolster. This is almost never done as it requires that the truck be practically dismantled.

Another cause of trouble is the rapid rounding of curves at which time the loaded car seeks a tangent and the trucks must follow the rails. That causes the bolsters to exert more pressure on one set of springs than on the other, thus allowing the springs to slip and quite frequently lose out. Improper side bearing spacing and clearance are very usual causes of truck failure and also cause derailment.

The principal instructions would seem to be to keep the truck tight and see that wooden shims, above or below springs, are renewed at sufficient intervals to insure that they are solid. The shims are made of seasoned oak, but they decay very rapidly and allow the springs to settle into them, thus increasing clearances to an unsafe margin. Side bearing clearances must be kept at the proper point, 1/8 in. to 1/4 in. between top and bottom.

REPAIR OF TANKS.

Of the tanks proper little need be said except that all *indications* of leaks should be immediately looked into as stains on the *outside* usually mean that the caulking edge of the sheets and rivets on the *inside* has deteriorated. The tank should not only be caulked on the outside, but more especially on the inside. It might be stated that caulking on the inside is almost never practiced except in the shop where its necessity is understood. The fact that inside caulking is obligatory, under Bureau of Explosives' Rules, seems to be overlooked. Leaks are quite commonly caused by deflection of the sheets of the unsupported end portion of the tank which causes distortion of the sheets at riveted joints.

The safety valves ordered to be used have always been a source of wonder to the writer, particularly as to why it seemed necessary to provide 40 sq. ins. to safety valve outlet surface while the largest locomotive using superheated steam and a pressure of up to 250 lbs. per sq. in. has only about 10 per cent of this area. The Master Car Builders Association has designed a device using a spring balance to determine the proper point at which to set the valve. Inequalities of bearing surface on the valve seats seem to be overlooked, consequently there is practically no guarantee that the valves will hold any pressure whatever.

All valves should be removed and ground in with emery in oil, then set to the proper point under a test by compressed air. The valve question is not only a maintenance problem, but one in design, which we hope will have the attention of qualified engineers.

The advisability of keeping cars well protected by paint is too well known to require more than passing comment. That comment is mostly directed toward the policy of merely making the cars a good advertising signboard instead of seeing that the painting is properly done. Cars, particularly the tanks, should be thoroughly cleaned preparatory to painting as the improperly cleaned car will not hold the best paint made. My company has found it advisable to put the problems of painting up to the paint manufacturers, using their knowledge and experience in connection with our own.

One of the greatest causes of tank cars being neglected is the attitude of certain railroads, particularly at competitive points. When an inspector refuses a "Bad Order Car," a competing road's inspector will take it, and so drum up business for his road. If it is impossible to run the car in its condition as accepted, temporary repairs are made. In fact, anything is done that will get it out of the yard at the point of origin. The owner is very grateful to the railroads accepting the car and consequently the accommodating railroad gets the future business.

This policy can have only one result, and that is evident when it is stated that the policy is pursued in endless chain fashion, the original road accepting cars that even the first offending road refused to handle.

Quality of Coal for Pulverized Fuel.

It has been generally understood that a large proportion of volatile matter is a leading requirement for pulverized fuel on account of its combustibility, but experience does not support this idea. On the contrary, many consider it expedient and beneficial to drive off a portion of the gaseous content of a coal before it is burned.

The temperature of combustion hearths for pulverized coal range from 2,200 deg. to 3,000 deg. Fah., depending on the design of furnace, the service, and the fusibility of ash and refractories employed. With these temperatures predominating, the deflagration of all commercial coals is assured, and the restriction in any particular kind of coal for powdered fuel on account of combustibility is eliminated.

The suitability of coal for use as powdered fuel is to be gauged by its pulverizing qualities, and the soft grades, which incidentally contain a large proportion of volatiles, are to be preferred. Hard coals and coke are very severe on the mills. For pulverizing, slack coal and all small sizes under 3/4 in. are desirable in that they eliminate the necessity of crushing. Screenings, which usually are fragments of the more combustible portions of coal, are excellent for pulverizing on account of the lesser amount of impurities present.

Uniformity in the quality of pulverized coal is as essential as uniformity in the fineness of the powder, and for continuous reliable service it is extremely important to mix and blend the coal so as to uniformly distribute its impurities. The ill effects of the irregular presence of impurities are felt more as the quantity of fuel burned becomes smaller. When burned in large quantities—necessitating larger combustion space—there is a chance for equalizing the variation of the impurities. To obtain a uniform quality of fuel wherever the coal supply is of varying kind the various grades of coal may be blended to advantage by pulverizing, thereby effecting economies which might not otherwise be realized.

Metallurgy of High Speed Steel

The article published in our delayed November issue on the subject of "Metallurgy of High Speed Steel," was composed of excerpts from an address delivered by Mr. Roy C. McKenna, president of the Vanadium-Alloys Steel Company, Latrobe, Pa., and should have been credited to that expert metallurgist. The paper was read before the first annual convention of the American Steel Treaters' Society, which was held at Chicago in September last.

Watt's Engines.

Among the several examples of steam engines, built by James Watt, the one at Bordesley, near Manchester, England, is in the most authentic preservation. This engine was built in 1795 and remains very much in the condition in which it was erected. It is the best example of a Watt pumping engine, and during the recent celebrations it was a center of attraction. It is the intention of the committee to preserve the interesting relic in its place.

Three Types of Locomotives for the

Atchison, Topeka and Santa Fe Railway System

The motive power of the Atchison, Topeka and Santa Fe Railway System has always been distinctive by reason of its high capacity. This has been due in part to the progressive policy of the management, and also to the fact that a considerable portion of the line is located in mountainous country, while operating classes of locomotives are generally similar; and in accordance with Santa Fe practice the locomotives are designed, as far as practicable, with interchangeable detail parts.

The following particulars apply to all three types of locomotives: The boilers are of the wagon top design, equipped trucks of the Commonwealth swing bolster type. In this design of truck, the frames, pedestal jaws, center casting and allied parts are all made in one piece, thereby adding strength and reducing maintenance costs by eliminating bolts. The Santa Fe type locomotives are equipped with the Franklin Railway Sup-

PACIFIC 4-6-2 TYPE LOCOMOTIVE FOR THE ATCHISON, TOPEKA AND SANTA FE.
Baldwin Locomotive Works, Builders.

conditions have made it imperative to run exceptionally heavy train units in both passenger and freight service. On the more level sections of the line, through passenger traffic is largely handled with locomotives of the Pacific (4-6-2) type which have, to a considerable extent, replaced the Atlantic (4-4-2) type of locomotives, formerly used. On the sections having steep grades, the Mountain (4-8-2) type is giving excellent results in passenger service, and the with fire-tube superheaters. A fire-brick arch is installed which is supported on four 3½-inch tubes. On all these locomotives, careful attention has been given to the general proportions of the design, with a view to providing ample boiler power in relation to the weight on the driving wheels and the tractive force developed. This is particularly true in the case of the Pacific type locomotives, which are intended for fast passenger service, and must be capable of develop- ply Company's front truck with constant resistant rockers.

Walschaerts valve gear is used in connection with a Type B Ragonnet Power Reverse. This gear was given much study, and is based on a careful analysis of the service records of previous Walschaerts gears used on this road. It is anticipated that the present gear will give long service without failures, and at the same time maintain the proper valve events for good distribution of steam.

MOUNTAIN 4-8-2 TYPE LOCOMOTIVE FOR THE ATCHISON, TOPEKA AND SANTA FE.
Baldwin Locomotive Works, Builders.

Santa Fe (2-10-2) in freight. The Mountain type locomotives are a direct development of two experimental engines of this type, which were built for the Santa Fe Systems in June, 1918. The Santa Fe type originated on this system and hence is most appropriately named.

The road has recently received from The Baldwin Locomotive Works, locomotives of the three types mentioned above. The specifications for these three ing large horse power in proportion to their weight.

Much thought was given to the design of the frames and the transverse bracing. Large frame fillets have been used throughout, giving ample sectional area at points where breakage is liable to occur. All three classes of locomotives are equipped with the Hodges Improved design of trailing truck. The Pacific and Mountain type locomotives have leading

The Pacific type locomotives are hand-fired and are equipped with steam-operated slope sheet coal pushers having 15-inch cylinders. Duplex stokers are applied to the Mountain and Santa Fe type locomotives.

An interesting feature resulting from the application of the stoker is the use of auxiliary shafts for transmitting the power of the grate shaker to the grate shaker rods. The auxiliary grate shaker

shafts are placed above the center of the ash-pan. When such shafts are not used the grate rods are located near the sides of the ash-pan and interfere with ashes and cinders sliding down the slope to the hoppers. This allows the ashes and cinders to accumulate at the sides of the ash-pan, and prevents air from entering, thereby interfering with proper combustion and affecting the steaming of the locomotive. These auxiliary shafts are an important factor in aiding proper combustion and free steaming.

In the Pacific type locomotives, the auxiliary dome is placed immediately in front of the fire-box and back of the main dome. In the case of the Mountain and Santa Fe type locomotives, combustion chambers are used, and there is not room to place an auxiliary dome and man-hole back of the main dome. The auxiliary dome, therefore, is placed ahead of the main dome on the left-hand side, so that the throttle dry pipe will not prove an obstruction when the boiler is entered for inspection. In all these boilers, the longitudinal seam in the dome course is placed on one side instead of on the top center line, as was formerly frequently the case.

The location of the various cab appliances was given much consideration, and the steam gauges, water glasses, etc., are placed where they can be conveniently seen from both the engineer's and fireman's seats. The lubricators, gauge cocks, cylinder cock levers, etc., are within easy reach, and the blowoff cock handles can be operated when in position to see the water glass. The steam turret is located outside of the cab with handles for the various pipe connections extending into the cab and terminating near a single bracket, easily reached by the crew. The injectors are of the non-lifting type, and are located under the cab.

Special attention should be called to the large capacity of the tenders used with these locomotives. All the tender trucks are of the six-wheeled type; and the tank capacities for the passenger and freight locomotives are 12,000 and 15,000 gallons respectively. These are the first tenders of 15,000 gallons' capacity to be used on the Santa Fe system. The tender frames are all of the Commonwealth cast steel type, and those of the freight locomotives are especially notable because of their large size.

The following are the general dimensions of the three types of locomotives:

Pacific 4-6-2 Type.

Gauge, 4 ft. 8½ ins.

Cylinders, 25 ins. x 28 ins.

Valves.—Piston, 14 ins. diam.

Boiler.—Type, wagon-top; diameter, 78 ins.; thickness of sheets, ¾ in., 13-16 in., 27/32 in.; working pressure, 200 lbs.; fuel, soft coal; staying, radial.

Fire Box.—Material, steel; length, 114 ins.; width, 84¼ ins.; depth, front 84 ins.; depth, back 75 ins.; thickness of sheets, back, crown and tube ½ in. and sides ⅜ in.

Water Space.—Front, 5 ins.; sides, 5 ins.; back, 4½ ins.

Tubes.—Diameter, 5½ ins. and 2¼ ins.; material, 5½ ins. steel, 2¼ ins. iron; thickness, 5½ ins. No. 9 W. G., 2¼ ins. No. 11 W. G.; number, 5½ ins., 40c 2¼ ins., 214; length, 21 ft.

Heating Surface.—Fire box, 235 sq. ft.; tubes, 3,842 sq. ft.; firebrick tubes, 33 sq. ft.; total, 4,110 sq. ft.; superheater, 942 sq. ft.; grate area, 66.5 sq. ft.

Driving Wheels.—Diameter, outside 73 ins., center 66 ins.; journals, main 11 ins. x 13 ins., others 10½ ins. x 13 ins.

Engine Truck Wheels.—Diameter, front 33 ins.; journals, 7 ins. x 12 ins.; diameter, back 50 ins.; journals, 9 ins. x 14 ins.

Wheel Base.—Driving, 13 ft. 8 ins.; rigid, 13 ft. 8 ins.; total engine, 35 ft. 3 ins.; total engine and tender, 71 ft. 10⅞ ins.

Weight.—On driving wheels, 179,500 lbs.; on truck, front 50,600 lbs.; on truck, back 60,800 lbs.; total engine, 300,950 lbs.; total engine and tender, 534,670 lbs.

Tender.—Wheels, number, 12; wheels, diameter, 33 ins.; journals, 5½ ins. x 10 ins.; tank capacity, 12,000 U. S. gals.; fuel capacity, 16 tons; service, passenger.

Mountain 4-8-2 Type

Gauge, 4 ft. 8½ ins.

Cylinders, 30 ins. x 32 ins.

Valves.—Piston, 15 ins. diam.

Boiler.—Type, conical wagon-top; diameter, 88 ins.; thickness of sheets, 1-1 3-6 ins., 2-3 9-2 ins.; working pressure, 195 lbs.; fuel, soft coal; staying, radial.

Fire Box.—Material, steel; length, 132 5-16 ins.; width, 96 ins.; depth, front 92⅞ ins.; depth, back 79 ins.; thickness of sheets, back, crown and sides ⅜ in., tube 9-16 in.

Water Space.—Front, 5 ins.; sides, 5 ins.; back, 4½ ins.

Tubes.—Diameter, 5½ ins. x 2¼ ins.; material, iron; thickness, 5½ ins. No. 9 W. G., 2¼ ins. No. 11 W. G.; number, 5½ ins., 50; 2¼ ins., 275; length, 21 ft.

Heating Surface.—Fire box, 285 sq. ft.; combustion chamber, 112 sq. ft.; tubes, 4,894 sq. ft.; firebrick tubes, 37 sq. ft.; total, 5,328 sq. ft.; superheater, 1,298 sq. ft.; grate area, 88.3 sq. ft.

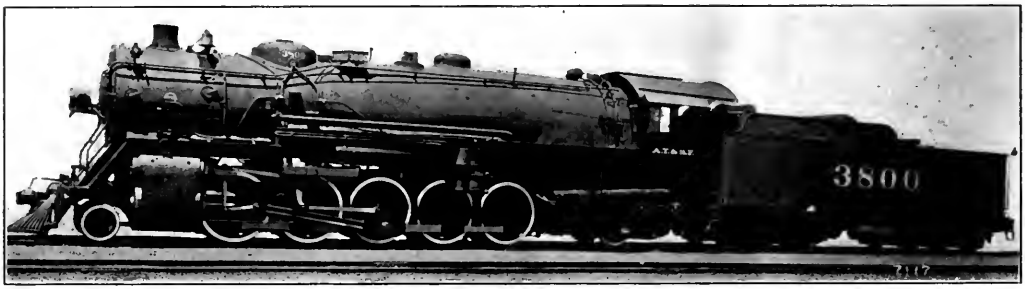
Driving Wheels.—Diameter, outside 63 ins., center 56 ins.; journals, main 13 ins. x 12 ins., others 11 ins. x 12 ins.

Engine Truck Wheels.—Diameter, front 30 ins.; journals, 7 ins. x 12 ins.; diameter, back, 40 ins.; journals, 9 ins. x 14 ins.

Wheel Base.—Driving, 22 ft.; rigid, 22 ft.; total engine, 41 ft. 7 ins.; total engine and tender, 85 ft. 2 ins.

Weight.—On driving wheels, 309,300 lbs.; on truck, front, 25,800 lbs.; on truck, back, 61,500 lbs.; total engine, 396,600 lbs.; total engine and tender, 673,600 lbs.

Tender.—Wheels, number, 12; wheels, diameter, 33 ins.; journals, 6 ins. x 11 ins.; tank capacity, 15,000 U. S. gals.; fuel capacity, 20 tons; service, freight.



SANTA FE 2-10-2 TYPE LOCOMOTIVE FOR THE ATCHISON, TOPEKA AND SANTA FE.
Baldwin Locomotive Works, Builders

Santa Fe 2-10-2 Type.

Gauge, 4 ft. 8½ ins.

Cylinders, 28 ins. x 28 ins.

Valves.—Piston, 15 ins. diam.

Boiler.—Type, conical wagon-top; diameter, 82 ins.; thickness of sheets, ¾ in. and ⅞ in.; working pressure, 200 lbs.; fuel, soft coal; staying, radial.

Fire Box.—Material, steel; length,

122¼ ins.; width, 84¼ ins.; depth, front 91½ ins.; depth, back 77¼ ins.; thickness of sheets, sides, back, crown and tube, ⅜ in.

Water Space.—Front, 5 ins.; sides, 5 ins.; back, 4½ ins.

Tubes.—Diameter, 5½ ins. and 2¼ ins.; material, iron; thickness, 5½ ins. No. 9 W. G., 2¼ ins. No. 11 W. G.; number, 5½ ins., 43; 2¼ ins., 254; length, 21 ft.

Heating Surface.—Fire box, 246 sq. ft.; combustion chamber, 90 sq. ft.; tubes, 4,428 sq. ft.; firebrick tubes, 38 sq. ft.; total, 4,802 sq. ft.; superheater, 1,086 sq. ft.; grate area, 7.5 sq. ft.

Driving wheels.—Diameter, outside 69 ins., center 62 ins.; journals, main 12 ins. x 12 ins., others 11 ins. x 12 ins.

Engine Truck Wheels.—Diameter, front 33 ins.; journals, 7 ins. x 12 ins.; diameter, back 47 ins.; journals, 9 ins. x 14 ins.

Wheel Base.—Driving, 18 ft.; rigid, 18 ft.; total engine, 39 ft. 5 ins.; total engine and tender, 76 ft. 8⅝ ins.

Weight.—On driving wheels, 244,100 lbs.; on truck, front 57,500 lbs.; on truck, back 64,500 lbs.; total engine, 366,100 lbs.; total engine and tender, about 608,000 lbs.

Tender.—Wheels, number, 12; wheels, diameter, 33 ins.; journals, 5½ ins. x 10 ins.; tank capacity, 12,000 U. S. gals.; fuel capacity, 16 tons; service, passenger.

Logging Railroads in Swamps and Bottomlands.

John B. Woods, Forest Engineer.

Of the fifteen thousand lumber manufacturers in this country, not less than one thousand are really big concerns, carrying investments of several millions of dollars and handling their affairs along modern lines. Naturally these companies build and operate railroads for transporting their raw materials from woods to sawmills, and as the trackage involved aggregates a goodly number of thousands of miles the business of building logging railways is important from several viewpoints. In the old days logging foremen handled their work by rule of thumb. If a railroad was to be built, the man in charge strode into the woods with a hand-axe and blazed a trial in the direction he desired his track to extend. He attempted to follow the best possible course and to make the line as short as could be, but human beings cannot combine the accuracy of level and transit, so old-time logroads usually took the form of snakes and carried grades too complicated to be navigated with fuel economy. Nowadays the science of logging-engineering has come to be a highly specialized calling, whose practitioners combine sound common sense with technical training in several engineering branches. That is, they possess these qualifications if they succeed in the work. And not the least among the tasks falling to the logging boss is the building and operating of these temporary roads.

Mountain logging has its problems of gradient and direction. Certainly such logroads are most expensive to construct. Flat land work is simple and a joy to the logger, except where flood waters enter into the proposition. Given flooding rivers, or the soft ground of southern swamps, and the matter becomes one of extreme difficulty, almost as troublesome as mountain building. For always the lumberman must keep his sense of balance. He must expend money for railways only to the extent that the body of timber to be moved will justify the expense. If a given line, five miles in length, will serve to handle twenty-five million feet of timber, the builders may feel justified in spending twenty-five thousand dollars for the road. Thus the timber will bear an initial logging cost of one dollar per thousand feet, which in good times, with lumber bringing fair prices, might not be considered excessive, even though subsequent operation and direct logging charges might bring the total cost up to seven or eight dollars per thousand. But given hard times, or given only ten million feet of timber along the five miles, and a different situation is faced. Under such conditions the logging engineer feels it his duty to build just as cheaply as he can, taking chances perhaps of losing an occasional train by wrecking, upon a less secure track. Or if the flood waters of every year are expected to destroy the railroad, the builder will distribute his expenditure over a number of years by building just as flimsy a line each Spring as will allow operation of his trains.

A certain lumber company with forests and plant in Arkansas was confronted with the problem of building a new railroad yearly across a river and into the tract that lay within the bottomland area. For several years they patiently went in after the flood waters had receded and gathered up such scattered steel as was to be found, and such ties as had remained spiked to their proper rails. Grading was comparatively a simple matter and did not cost much, but even then the yearly loss of materials was too great to be borne with equanimity. So at last they put in a line and ballasted it with rock and awaited results. The track always had remained in fair condition, except for mud, in the places where the flood waters were merely back-wash, but this year every foot of the line, including the river crossing, remained in place, although at certain

A LOGGING ENGINE AT WORK IN THE FOREST.

points it had been eight feet under for distances of several rods. And the only expense to follow was that of removing driftwood and mud from the track. The bottom-lands builder always must take into consideration the reputations of his rivers, and usually he is wise to assume that the floods will go higher than they ever have in the memories of any of the natives whom he questions. And usually he is unable to cling to the higher ground because his timber lies down near the stream, and that timber is his only reason for using railroad. Furthermore, the soft ground makes team hauling very difficult during much of every year, so that he must lay steel as near to the trees as possible to cut down the cost of team labor.

There are two divisions of the ordinary log-road; the main-line and the spurs. Under the usual operation scheme the logs are loaded upon the various spur tracks, and the cars then are taken out to the junction point by geared locomo-

tives. These powerful machines are capable of hauling heavy loads over very poor roads and are the logger's salvation. The trains make up at the junction, where a rod-engine is waiting to take the logs to mill. Often the distance may be thirty miles, and as two trains usually are handled daily, loads going millward and empties coming out, fair speed must be maintained over the main line. During the early days of a given operation, while the main line extends only five or ten miles, this track may be rather poorly constructed and still serve, but when the line becomes several miles in length it must be kept in condition to allow thirty-mile-an-hour traffic in time of need. The spurs are designed to accommodate geared locomotives, trundling along at speeds of from three to ten miles per hour, and they seldom are more than five miles long. For big mills an average daily tonnage over the main lines of one thousand load tons and fifteen hundred tons of rolling stock is not abnormal, which is not heavy traffic, but still requires a considerable amount of track work.

In the swamps of the far southern states the cypress people have developed a type of railroad that is very interesting. In early days they used pull-boats for getting out their logs, but as it finally became necessary to dredge canals into the swamps this method was considered too expensive. And the operators finally decided to try building railroad, even though their timber grew out of soft soil that was from a few inches to several feet under water during much of the time. After some experiments they have evolved a system that is quite successful, and they get their logs much more cheaply than the pull-boats can bring them in. The first step, after surveying the line, is to start work with a modified track-laying machine—a donkey engine mounted upon a flat car and equipped with a long boom. This device is pushed along to the end of the track already built and with the help of a crew of semi-aquatic negroes all the small trees and logs to be found in reach of the cable are hauled up and laid down across the the line of the survey. Of course this pre-supposes the cutting of such trees ahead of the track, and if the clearing of the right of way does not yield enough material for the corduroy, other trees are cut ahead of the machine. This corduroy is piled to a depth of two feet or so, and then ties are laid down and the rails line-spiked to allow passage of the track machine. Thus the line rests upon a continuous blanket, two feet deep and about twelve feet wide. After logging begins, crews of workmen are kept upon the track and as fast as a weak spot appears it is plugged with chunks of wood, and the track shimmed up to grade. Of course there are no grades to bother the builders, as the swamps are practically level, and no effort is made to seek high spots. When the track overflows to more than two feet the locomotives are stopped, but as soon as the water begins to recede the engineer gets out his drift-scoop and with it proceeds to steam along the line, pushing driftwood away from the track so that logging can recommence. If he waited for the water to disappear, he would find his line buried in wood and mud; in fact, he would not operate much of the time except in Summer, because there usually is water in greater or smaller quantities all of the time. But the locomotives can work to advantage even in two feet of water.

Naturally all equipment must be light. Engines usually weigh about sixteen tons, and the more drivers and pony trucks they possess, the better. Although the logging is done with steam skidders, they are brought in upon flat cars and are set off upon specially constructed sidings before beginning operations. Log-cars are light, but very strong, and the loads carried upon them are somewhat lighter than those handled upon solid ground farther north. When a train arrives at camp the logs are dumped into the river, where they are made up into rafts and towed to mill behind steamboats. Some companies who operate extensive railroads in the swamps bring mill-waste out in barges and fill in between the cross-logs with this stuff to improve their track, but unless there are long lines of track to be used the extra cost is not justified. Given careful engineers the corduroy roads are very satisfactory and produce very few wrecks. But to a public-carrier man they certainly do present a weird appearance.

Automatic Train Control

It is noteworthy to observe that the results of inspection of safety-appliances on railroads has shown that there was a decrease for the past fiscal year in the percentage of defects on mechanical equipment, the number per 1,000 locomotives and cars inspected being the lowest in the history of safety appliance inspection. In locomotives the per cent defective being 1.84; passenger cars, 0.39, and freight cars, 3.7. This is very gratifying in view of the difficulties in maintaining a thorough repair of equipment, and the constantly increasing volume of traffic.

Of the 79 train accidents investigated, 53 were due to collisions, 25 derailments, and 1 classified as miscellaneous. Of the collisions, 28 occurred on lines operated by some form of block signal system, 19 on roads operated by time table and train order systems, and 6 were yard accidents. In automatic block signal territory 18 of the 28 alluded to occurred, and it is clearly pointed out that these accidents were due, directly or in part, to the failure of enginemen properly to observe and obey signal indications; in some cases neglect of duty by flagmen was a contributing cause. The fact that these accidents occurred on roads where the best trained and most competent men are employed emphasizes what we have long contended, that by no system of training or discipline can the failure of the human equation be entirely prevented so as to avoid accidents of this character.

The only remedy thus far proposed that appears at all likely to provide full protection against the occurrence of collisions is the adoption of some form of automatic train-control system that will insure obedience to automatic block-signal indications. During the year plans of 80 devices were submitted to the Bureau of Safety. Revised plans of 15 devices that had been previously examined were submitted for further consideration, and 4 of these latter devices were commended to the extent of warranting further development or trials under service conditions. Favorable reports, so far, show that 8 automatic train-control devices have been specially recommended for experiments in service, with a view to taking decisive action as to the choice of the most worthy of approval.

During the year tests were conducted of the automatic train-control system submitted by the National Safety Appliance Company, San Francisco, Cal. This device is of the magnetic induction type, employing permanent magnets in both track and locomotive equipment, as well as an electromagnet on the track for nullifying or neutralizing, when desired, the effect of the permanent track magnet. Tests were made on the Western Pacific and the Southern Pacific and reported:

"While as a whole the tests made are not considered conclusive, it has been demonstrated that, with the exception of one of the locomotive-control valves used in the tests, the locomotive apparatus, so far as could be determined, operated as intended, and whenever actuated by the track-magnet impulse it accomplished the functions for which it was designed; further, that the transmission of a magnetic impulse from a permanent magnet installed on the track to locomotive apparatus designed to be controlled and actuated thereby is both practical and feasible. The fundamental principles upon which this system is based have therefore been demonstrated to be sound and practicable, but the available working limits, as well as the reliability of the transmission and control of the actuating impulse, remain to be fully established. For these purposes further development work, as well as more extended trials under practical service conditions, is necessary."

Snap Shots on Research

By the Wanderer

We learned much in the war. Very much more than we ever learned in so short a time before. But have we really learned what we learned? We have done a lot of things that we have never done before, and done them with amazing quickness. It was a case of woodchuck. The minister was coming to dinner and we had to have some meat. So we learned that if we wanted to get at the secrets of Nature in the way of poison gases, aeroplanes, efficient motors and depth bombs, we had to hunt for them. In short, intensive research was the cry, and we found that it paid. We found that the patient plodding of our enemy was a sort of worth while quality after all.

But it is hard to teach an old dog new tricks, and the dog of American commercial life is a pretty old fellow, and has been fed so long in his protected industry by the bountiful supply of food laying around loose, that he does not take kindly to a life in the woods, where he must either starve or catch the squirrel before he can take to the tree. So it is more than likely that his ardor for research will cool considerably now that the pressure of necessity is removed. He will be more likely to nose around the domestic garbage can than take to the open in a hunt for fresh meat. Then, when the garbage can is empty, well—we have heard much of this cry for research, research, but has it really struck home? I ha' me doots.

For example, a few days ago I wrote more than forty letters to the manufacturers of a certain class of specialties, asking for information regarding the operation of that specialty under the every-day working conditions, what modifications they made for slight variations in conditions; simple every-day questions that ought to have been put to their salesman a thousand times a month. Did they answer them? Not one. They simply didn't know. *"Caveat emptor!"* "Let the buyer beware" had been and is their motto. If the goods are satisfactory "Why should I worry?" Why, indeed? Yet every mother's son of the whole bunch would have risen in admiration and applause at an investigation of almost any kind that gave results. It is just inertia and the reluctance to spend a dollar unless it has such a string tied to it that it is sure to come back dragging another with it. Yet they all believe in research—for the other fellow. As Louis Mann in the Tyrolese innkeeper remarked, "It is to laugh."

Sometimes the scoffer becomes a convert, and then, like all proselytes, "it is to laugh" to see how he jumps into the game. A certain well known man, so well known in fact that if I should name his name you would all sit up and take notice, and many would say, "I knew him." A certain well known man, I say, had been very successful in the exploitation of a number of railway specialties that he had devised and had gathered in a goodly number of ducats thereby. Then he launched into a really big thing. So big that he hoped to catch the world. He laid his plans and felt that he was right. He thought he could swing the United States, but abroad he needed assistance. But somehow he run up against a lot of Missouri skeptics both at home and in England. He could place a few samples on trial at his own expense, but the English would have none of him, and there were no sales at home. Things looked black. His manager was a young man, who believed in the goods, yet realized that to sell he must have a Q. E. D. now and not wait ten years for a trial to end. So he engaged an engineer to look into it. It was a slow piece of work, and the principal chafed and fumed and probably swore, that all this tom-foolery was a waste of time and money. He wouldn't have it, and the whole thing would have to stop. But the manager, who was a member of his family, said, "Nay, nay; we go on." And go on they did.

It took nearly a year for the preliminary investigation to determine the relative merits of the new thing with the articles already on the market with which it was to compete. Then? Well, at the first crack out of the box, and the first presentation of the report, there resulted an order of about $50,000. The principal tucked the report under his arm and sailed for England. Two weeks sufficed to close a deal for the making of the specialty there. The convert came home, and the work was continued to the end. Result? Well, what could you expect? The thing became a great success, and the owner almost childish in his enthusiasm for research work.

But sometimes it doesn't work that way. Another specialty was on the market. Not altogether based on strictly scientific principles, but which looked good and had good talking points. It sold on its talking points, and the talkers were making money. They, too, were sure of themselves, and they, too, wanted a Q. E. D. So an elaborate investigation was planned and carried out. But somehow the theories did not hold in the tests. The article failed, not badly, but its practical success was only an emphasis of what it nearly was. The report was unsatisfactory, the talkers half thought, though they did not give utterance to the thought, that they had not had a square deal. The report was filed away among the secret archives, and there it lies. May it rest in peace. But the talking went on, the sales went limpingly on, and the talkers have ceased to believe in the efficacy of research work as a means of trade exploitation.

Then there was that other crowd. They had a good thing and knew it, or thought they knew it. And they, also, proceeded to investigate. It took the better part of two years to do the work. And when it was done, oh the joy that was in it. All the carping criticism was silenced. There could be no mistake, this was the real thing. And how they exploited the results. The coasts of the Atlantic and Pacific and all the intermediate terrain were flooded with the "Here's the thing to use." But—oh, but, there was still a skeleton in the closet. A nasty skeleton of whose existence there had been many surmises and more questions. But if no one had really seen your skeleton you can lock the door and deny his existence, or if the inquirer be too insistent, you can gloss its existence over and say it isn't much of a skeleton, anyway. So that is what was done. The suggestion of a further investigation was frowned upon. To find out whether it was a really truly skeleton or merely a nightmare of one, was thought unwise. We don't know that we have a skeleton. It is only a suspicion. So long as we keep the door closed "neither you nor I nor nobody knows." But if we should unlock the door, and it should really jump out at us, why, some of our friends might be scared to death. "Where ignorance is security (with apologies to Gray) 'tis folly to be wise." So we will walk bravely by the door, and if any chose to believe that it hides a skeleton, why, let them. Who cares; they can't prove it. So there you are. You pays your money and you takes your choice.

Does research pay? He loves me, he loves me not. Doesn't it pay to know just where you really stand? Do you post your ledger on your front door? Do you tell all of the secrets of your business, your family, yourself to the world? Yet you keep books for your own information; you maintain your family for the joy of life; you guard your own life because it's about the best thing you have, much as you may have abused it. So possibly it may be well for you to know some unpalatable things that you may be guided to things that are better and to get to that which is better, there is no better way than by painstaking research.

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A Locomotive Chart.

The locomotive chart of a Pacific engine which is now issued by us will be a valuable addition to locomotive references and the most complete of anything of the kind that has yet been published. While it is not a complete locomotive dictionary it will, nevertheless, serve as a very satisfactory abridgement of such a publication. The reference numbers, about 700 in all, in the list of parts will be especially valuable as a means of study to those who are learning the locomotive and who wish to become acquainted with the relative positions of the several parts and the interrelationship that exists between them. This is a matter that can best be learned by a representation of a complete locomotive. Books on the subject must necessarily deal with details or at least limited assemblages of details, and the student is obliged to either piece these together or refer them to an assembly of a complete locomotive and imagine the details in place. Besides this, assembled, drawings are usually made for the purpose of showing either the external appearance of the entire machine or one side of it or a limited number of parts. In the chart, on the other hand, great liberties have been taken. A hole has apparently been cut through the boiler in order to show the air pump and the details of its construction upon the left hand side of the engine.

Then the view of the interior of the cab is a novelty in this sort of work. Heretofore the illustrations of cab interiors have served mainly to show the complicated mass of material placed upon the back head of the boiler, with no attempt to separate the parts. In this case there is a designation for each piece amounting to something more than a hundred in all, and while the details of their construction could not be shown their relative locations are distinctly brought out. All of which goes to substantiate the claim that this is probably the most complete locomotive dictionary in an abridged form that has ever been published.

Not only so, but the great popularity of the charts published by us, some editions of which have exceeded a hundred thousand, is the best proof of the abiding, educational value of such publications, and take their proper positions as works of standard reference, wherein the information sought for is within easy reach, and the satisfaction obtained by the seeker after information is not only easy of accomplishment but complete in its element of correctness.

Power and Responsibility.

When a man has a dollar to spend he will, if he is wise or prudent, have a care that he receives the worth of that dollar when he parts with it. If he agrees with another to pay for any article he assures himself that the other is able to and will deliver the article in question. This is the basis of all contracts. And when a contract has been made it is usually held to be binding on both parties and each is liable to the other for damages incurred because of the failure to fulfill a part or all of it. In short, the whole value of a contract of any character rests upon the mutual responsibility and reliability of the two contracting parties.

Likewise any partnership is based upon mutual responsibility, and no business relationship could or would be tolerated where one member of the firm or one party to the contract was vested with authority to dictate policy and was free from any obligations resulting from the execution of that policy. Nor can a just contract be made if it is to be held to be binding on one of the parties while the other is free to break it or abide by it as the whim of the moment may dictate.

And yet this is exactly the condition of affairs that the advocates of collective bargaining urge, when they hold for the full responsibility of the employer and discard any and all responsibility for the employee. And so long as such a position as that is advocated just so long will collective bargaining be in dispute. From the standpoint of the unskilled workman, who is but one of a mass, it is a most desirable method of wage adjustment, and it would be equally desirable to the employer, provided the representatives of the employe had the power and could be held to the exercise of it to hold their clients to the fulfillment of the contracts that they make. Willingness, ability and responsibility is all that is asked. This done, and the related evils of labor turnover and strikes would be largely mitigated.

But the leaders who are loudest in their advocacy of collective bargaining are just the ones that fight most vigorously against the placing of any responsibility for the fulfillment of their contracts on their own shoulders or upon those of their clients. Public sentiment for fair play and honesty of purpose and dealing is needed to bring about a change in this attitude, and this public sentiment must come from an aggregation of individual sentiment among the members of the body of employes who are represented by the collective bargaining. Without disparaging isolated individuals it is doubtful if such a sentiment will soon develop into a power sufficient to accomplish tangible results from the sickly seeds of the few well disposed. It looks as though honesty would have to be forced upon the mass, for their own good and that of the community, just as the common honesty of thou shalt not steal is forced upon the great majority of mankind.

The idea that the workman should have a voice in the management of the business through which he earns his livelihood appears plausible, but if he assumes that authority he should also be willing to assume full responsibility for and be willing to share in the losses of the concern as well as in its profits. And this he has, thus far, been unwilling to do. Where definite propositions to this effect have been made the men are reluctant to accept them. For example, the English government offered to turn over one of its national shipyards to one or another of the great trade unions, and the offer was not accepted. If some such offer as this were to be accepted and earnestly worked, it is probable that much light would come to the men as to what the successful prosecution of a great industry involves. That this light has already reached their leaders is evidenced by their reluctance to accept responsibility with the authority for which they are clamoring.

This is essentially what is asked for in the Plumb plan for the nationalization of the railroads. It asks that the country invest millions in the purchase of the roads and then turn them over to irresponsible men to manage, men who would

be unwilling to share losses, but who demand an interest in the profits if there are any.

The suggestion is, therefore, made that if the game is to be played at all it should be played openly and above board, and not with stacked cards or loaded dice.

An Appeal for the Returned Soldiers

Major Frederick M. Crossett, chief of the relations section, Chemical Warfare Division of the United States Army, Washington, D. C., has sent out an appeal to manufacturers and supplymen generally, and also to railway managers, to employ discharged soldiers wherever possible, and calls particular attention to the number of men qualified for service in chemical laboratories. The railroad testing plants are in need of experts in chemistry, and we heartily join in Major Crossett's appeal that those men who have served our country so nobly in the chemical branches of the army service should have a preference, especially wherever and whenever they are qualified by experience. It will invariably be found that army training has a quickening effect on the mental and physical ability of the veteran, and it is gratifying to learn that the good work of finding employment for the discharged soldiers has been taken up so whole-heartedly. It need hardly be pointed out that it is not enough that men should be promptly re-employed in their old positions, but when vacancies are constantly arising it should be remembered that we owe more to the men who made up our triumphant army than we will ever be able to pay. Many of those in the chemical warfare service gave up excellent positions to join the service.

Chemists of all classes qualified both by education and experience are available, and if you are in need of one or more of them, communicate with Major Frederick M. Crossett, U. S. A., Washington, D. C. We are sure the results will be most gratifying.

Pay by Classification.

Classification is a wonderful thing, but never so wonderful, so Aladdin-like, as when it is handled by some employee or agency of the National Government. On one of our railroads a water tank was looked after by a near-by farmer. He turned an electric switch in the morning, and went about his bucolic business, then came back around six in the evening and turned off the switch. That was all he did for the railroad company, and for this service he received about $20 a month. Then Uncle Sam took over the railroads and at once began to "classify" the employees. Was the tender of the water tank a farmer or an electrician? Manifestly a farmer could have nothing to do with the operation of a railroad, so he was classed as an electrician. But the wages of an electrician according to classification, would be $300 a month. So, without requiring any further work from him, the farmer was classified as an electrician, at the proper scale of pay, and besides was given "back pay" amounting to some $3,000. Need it be added that one farmer at least in the United States is now a firm believer in Government ownership and operation of our railroads? Surely the power that could make an electrician out of a farmer by the stroke of a pen would find it mere child's play to run our railroads—especially as you and I and the rest of us would foot the bills.

An Investigation of Bearing Metal.

A paper was presented before a recent meeting of the Metal Institute in England detailing some investigations that had been made on a bearing metal composed of approximately 4 per cent. copper, 9 per cent. antimony and 87 per cent. tin. The metal was cast into small ingots measuring ½ in. by ½ in. by 3 in., and in both hot and cold metal and sand molds and at different temperatures. The resulting ingots were examined microscopically and measurements of Brinnell hardness were made. It was recognized that Brinnell hardness is not even an approximate measure of the value of a bearing metal, but it was used because it is the only method of physical testing which is readily applicable to a large number of small ingots and because it serves as a general guide to the variation of physical properties accompanying different casting conditions and corresponding variations of microstructure.

The metal was cast at temperatures of 575°, 750° and 1,040° Fahr. in warm and cold sand, in cold metal and in metal heated to 210°, 390° and 660° Fahr.

The Brinnell hardness tests of the several ingots showed so little variation as a result of the different conditions and temperatures of casting that these variations may be considered as almost negligible quantities, though the variations in microstructure was quite marked. In the use of white metal bearings for marine and stationary use it is common practice to hammer-dress the cast bearings, for the purpose, no doubt, of closing up any cavities and generally improving the soundness of the metal.

In order to ascertain what the probable effects of this form of treatment on a bearing metal are likely to be, some experiments in hammering various ingots were carried out.

Six ingots, in all, were hammered and tested for hardness, the test being made on the hammered face within ten minutes of that operation and after only a very little of the surface had been removed by grinding. The ingots were then kept for half an hour at 210° Fahr. and re-tested. They were again heated to 210° Fahr. and maintained at that temperature for 16 hours and again re-tested.

The remarkable result of this treatment was that, while hammering alone, so far from hardening this alloy, actually brings the hardness down to a small extent (except in one case), hammering followed by annealing at 210° Fahr. results in appreciable softening. It is interesting to note that the fine-grained ingots stood the hammering comparatively well; one in particular being easily reduced by 58 per cent. The coarsely crystalline ingots cracked and broke after a small amount of hammering.

Microscopic examination of the specimens which had been subjected to hammering showed that both the cuboid and the copper-tin crystals had been, to a certain extent, crushed and broken by the treatment. This did not produce much apparent alteration in the structure of other ingots where the crystals were already small and evenly scattered in the matrix, though the uneven edges and irregular shapes of the broken cuboids are easily seen under a high magnification. In the coarsely crystalline samples the results of hammering are much more evident. In one case, that of an ingot poured in a mold having a higher temperature than that of the metal itself, and therefore very slowly cooled, it would seem that the hard copper-tin needles have been hammered on to the cuboids and have cracked them, and also that the needles themselves are broken successively at right angles to their long axis. Where the cuboids are not in contact with the copper-tin needles they appear to be much less damaged.

The observations set forth show that much can be learned from such a study, and particularly that the method of casting and treating these alloys must profoundly affect their behavior, since it affects their microstructure in such a marked manner. The remarkable results of hardness measurements on hammered specimens indicate that these alloys behave in a way which, by comparison with other alloys, must be regarded as anomalous. The practical question as to whether a bearing is injured or improved by hammering is left open, although it is difficult to believe that a treatment which shatters the harder crystals can be advantageous.

Ring out the old, ring in the new,
  Ring happy bells across the snow,
The year is going let him go,
  Ring out the false, ring in the true.

—*Alfred Tennyson.*

Air Brake Department

Questions and Answers

Locomotive Air Brake Inspection.

(*Continued from page 339, Nov. 9, 1919.*)

997. Q.—When the straight edge rests against the shoulder for the diaphragms, where should the end of the regulating valve be?

A.—Flush with the straight edge.

998. Q.—How will an incorrect length of regulating valve affect the operation of the feed valve?

A.—If too long the valve will leak by reason of not being returned to its seat; if too short, the feed valve will not be sensitive enough.

999. Q.—Why not sensitive enough?

A.—Because too much movement of the diaphragms will be required to unseat the regulating valve upon a drop in pressure.

1,000. Q.—What will be the effect of a slightly bent regulating valve stem?

A.—The valve will not seat properly through the stem coming in contact with the regulating valve cap nut, and will therefore leak.

1,001. Q.—What is to be noted in connection with the regulating valve spring?

A.—That it is in good condition and has not an excessive permanent set.

1,002. Q.—How is the regulating valve seat and the supply valve tested for leakage?

A.—By having the air pressure turned on with the spring box removed.

1,003. Q.—Why is it best tested in this manner?

A.—Because the end of the regulating valve will be exposed as well as the port leading down from the supply valve.

1,004. Q.—How should the spring box be tightened after cleaning and test is completed?

A.—With a wrench and just sufficient to prevent any leakage from the waste or drain port in the spring box.

1,005. Q.—What is the effect of this port becoming stopped up, or if none has been drilled in the box?

A.—If there is any leakage past the diaphragms the feed valve will not operate.

1,006. Q.—Why not?

A.—Air pressure will equalize on both sides of the diaphragms and the regulating spring will hold the regulating valve from its seat.

1,007. Q.—What else should be noticed in connection with the parts in the spring box?

A.—That the ends of the spring are oiled, and that neither the spring nor the diaphragm spindle bind in the box or in the adjusting nut.

1,008. Q.—What should be used for a lubricant for the supply valve and seat?

A.—Dry graphite.

1,009. Q.—Is there any lubricant to be used on any other part?

A.—No, only a drop on the ends of the regulating or adjusting spring.

1,010. Q.—Why none on the supply valve piston?

A.—Oil would act as a packing and prevent a prompt equalization of pressure on both sides of the piston.

1,011. Q.—And the result?

A.—An overcharge of the brake pipe every time the feed valve opened.

1,012. Q.—How is it that they are sometimes found with heavy boiled oil on the piston and still operate?

A.—It means that the piston is too loose or that the bushing is badly worn, and the oil assists in filling the space.

1,013. Q.—What must be noted in connection with the supply valve piston cap nut?

A.—That the stem in it is straight and not binding against the inside of the supply valve piston.

1,014. Q.—The result?

A.—A feed valve that cannot be made sensitive in operation.

1,015. Q.—What kind of a spring is used between the cap nut and piston?

A.—With the No. 6 valves, a nickeled steel spring of 15 coils, 2⅝ ins. in length.

1,016. Q.—With the No. 4 valves?

A.—A somewhat lighter spring, of 15 coils, of the same material, but on 2¾ in. free height or length.

1,017. Q.—What is this spring, a standard with in triple valves?

A.—Graduating springs for H and K triple valves.

1,018. Q.—What is the spring of the No. 6 valves standard with?

A.—Only with that of the brake pipe vent valve sometimes used on tenders.

-,019. Q.—What is used between the spring and piston?

A.—A piston spring tip.

1,020. Q.—What is it used for?

A.—To prevent the winding action resulting from the spring compression to rotate the supply valve piston.

1,021. Q.—What limits the travel of the supply valve piston?

A.—The piston spring tip and cap nut stem limit this travel and consequently the travel of the supply valve.

1,022. Q.—And if these parts are non-standard?

A.—They may restrict the port opening and supply to the brake pipe.

1,023. Q.—How long should a repaired feed valve vibrate against leakage before it is tested?

A.—At least 10 minutes.

1,024. Q.—What is usually wrong with a feed valve when the flow of air through it is slow as noted by the rise of the gage hand?

A.—There is generally a restriction in the ports of the valve.

1,025. Q.—How are these restrictions removed?

A.—By drilling out the brass plugs at the ends of the port holes, and renewing the plugs after the ports have been cleaned.

1,026. Q.—Which port is usually found to be closed?

A.—The one leading to the supply valve seat.

1,027. Q.—In what way?

A.—Brake pipe leakage may be permitted to start the brake application.

1,028. Q.—What is the difference whether leakage or the brake valve discharge starts the application?

A.—Leakage at a much slower rate of discharge may only move the triple valve piston instead of the piston and slide valve.

1,029. Q.—With what result?

A.—A bottling up of the auxiliary reservoir pressure, in which the slowly falling brake pipe pressure and failure of the triple slide valve to move, may produce enough difference in pressure to cause the triple valve piston to "jump" to emergency position when the slide valve finally does move.

1,030. Q.—Why might quick action be prevented under the same condition of the brake valve discharge having started the brake application?

A.—The reduction made with the brake valve would be more rapid, and when the piston engaged the slide valve, it would be in the form of a hammer blow, tending to dislodge the slide valve and start the brake to apply without obtaining the high differential between brake pipe and auxiliary reservoir pressure.

(*To be continued*)

Train Handling.

(*Continued from page 340, Nov. 1919.*)

1,050. Q.—What is wrong when a blow starts at the emergency exhaust port of the brake valve after a light application with either brake and return to

running position and the engine and tender brake will not release, but after an additional or heavier application the brake releases and there is no disorder manifested?

A.—The application piston packing ring is stuck in the piston groove or leaking very badly.

1,051. Q.—From where is the air pressure causing this blow?

A.—From the main reservoir through the brake cylinders into the application cylinder and out of the brake valve emergency exhaust port.

1,052. Q.—At what time in the year are such blows usually manifested?

A.—At the beginning of cold weather.

1,053. Q.—What other disorder will usually be found at the same time?

A.—Considerable friction or resistance to the movement of the application portion of the distributing valve.

1,054. Q.—How does the flow from the brake cylinders pass the application piston packing leather?

A.—This leather is only intended to prevent leakage from the application cylinder side, and any air that passes the piston ring from the brake cylinders is free to beat down the edge of the leather and flow into the application cylinder.

1,055. Q.—What is the effect of a leaky application piston packing leather?

A.—It may cause the brake to fail to apply with the independent valve in slow application position, or if it does apply, will require much longer than from 6 to 8 seconds to obtain 40 lbs. cylinder pressure.

1,056. Q.—Where would the bad leather tend to produce a blow?

A.—It would tend to cause a very slight blow at the distributing valve exhaust port before the independent brake applied.

1,057. Q.—What disorder would produce 15 lbs. or less brake cylinder pressure for a 10 lb. brake pipe reduction with the pressure chamber fully charged?

A.—A very badly equalizing piston packing ring, a leaky safety valve, or it might be due to a distributing valve reservoir partly full of water.

1,058. Q.—What would be wrong if the main reservoir, equalizing reservoir and brake pipe gage hands dropped back when the independent brake is applied?

A.—It would likely be caused by a restriction in the reservoir pipe of the locomotive.

1,059. Q.—Where could restriction occur?

A.—In any elbow, tee, or possibly an air strainer in the pipe, through a partly closed reservoir cock or possibly through the bushing in the reservoir cock having loosened and turned.

1,060. Q.—It has been explained that the feed valve controls feed valve pipe pressure with the brake valve in release position, and that there is a flow of air through the rotary valve into the feed valve pipe when the valve handle is on lap position. Is this latter flow of any considerable volume?

A.—No; but a very small port opening is made.

1,061. Q.—Can it be entirely stopped with the brake valve handle without admitting main reservoir pressure into the brake pipe?

A.—Yes, by crowding the brake valve handle back on the shoulder between lap and holding positions.

1,062. Q.—Is this of any consequence?

A.—Not particularly; it only emphasizes the importance of not permitting any excessive lost motion between the brake valve handle and the rotary key, or between the key and rotary valve, especially when the SG type of governor is used.

1,063. Q.—Can a train be properly handled with bad leaks in the brake pipe?

A.—No.

1,064. Q.—Why not?

A.—Because the amount of brake pipe reduction cannot be controlled from the brake valve.

1,065. Q.—Therefore, what does it do?

A.—Takes away from the engineer the ability to control the train.

1,066. Q.—When is brake pipe leakage on a freight train noted?

A.—During a test of brakes.

1,067. Q.—At what time?

A.—After a 15 lb. brake pipe reduction has been made for the test.

1,068. Q.—What is a fair permissible rate of leakage?

A.—It should not exceed 7 lbs. per minute from 55 lbs. brake pipe pressure, or 10 lbs. per minute from 80 lbs. pressure.

1,069. Q.—After stopping a train on a grade, should air brake or hand brakes be used to hold the train for a period?

A.—Hand brakes and the wheels should be chocked if necessary.

1,070. Q.—In coupling to a train on a grade with the wheels blocked, when should blocks or chucks be removed?

A.—After the brake test is completed.

1,071. Q.—What is wrong if main reservoir pressure falls during an application of the brake?

A.—It indicates excessive brake cylinder leakage or a main reservoir nearly full of water.

1,072. Q.—What does this tend toward on a grade?

A.—To produce a loss of train control.

1,073. Q.—In what way?

A.—The pressure escaping through the brake cylinders might be necessary for a recharge and re-application of brakes. Water in the main reservoir occupies space that should be used for compressed air.

1,074. Q.—With the automatic brake on the engine applied, how is it released and re-applied to produce 25 lbs. brake cylinder pressure?

A.—The handle is placed in release position, returned to running position long enough to release the engine brake, then placed in service position, and a 10 lb. brake pipe reduction, or rather equalizing reservoir reduction made after brake pipe and equalizing reservoir pressures become equal.

1,075. Q.—How can the brake be applied after a service application and release to produce a brake application so light that brake cylinder pressure will not register on the air gage?

A.—By making from 3½ to 5 lbs. equalizing reservoir reduction after the engine brake has released, and the equalizing reservoir pressure has been drawn down equal to that in the brake pipe. The amount of reduction will depend upon the condition of the distributing valve.

1,076. Q.—At what time would this be of advantage?

A.—During the second application of a two-application stop of a passenger train.

1,077. Q.—In case of emergency, should an engine be reversed in addition to applying the brakes in emergency?

A.—No.

1,078. Q.—Why not?

A.—It would result in the sliding of the driving wheels, and the distance of stop would be greater than if the wheels were revolving with the brake shoes applied even with a moderate degree of force.

(To be continued)

Car Brake Inspection.

(Continued from page 341, Nov., 1919.)

966. Q.—What would be wrong if the failure to apply was accompanied by a heavy blow from the service brake cylinder exhaust port?

A.—The exhaust valve would likely be off of its seat.

967. Q.—What would be wrong if the brake applied on a 4 lb. brake pipe reduction?

A.—The application piston spring would be very weak or broken.

968. Q.—Can you tell from the emergency brake cylinder side of the car whether the brake is applied or released?

A.—Yes, if the brake is applied with a service application, the piston lever of the emergency brake cylinder will be drawn away from the cross head the same distance that the service piston is out of the cylinder.

969. Q.—Is the piston also pulled out of the emergency cylinder?

A.—No; the cross head is slotted.

970. Q.—What should be observed when any change is made on the screw of

the automatic brake slack adjuster?

A.—That the crossheads of the two adjusters are the same distance from their respective cylinder heads.

971. Q.—Why is this?

A.—So that the brake cylinder piston travel of both cylinders will be equal when the brake is applied in emergency or quick action.

972. Q.—How is the distance of the cross heads from the cylinder heads maintained equal when the service cylinder operates many more times than the emergency brake cylinder?

A.—The same adjuster pipe operates both adjusters from the service brake cylinder, so that when the service brake cylinder leather passes a given point, both adjusters operate at the same time.

973. Q.—What would be wrong if both cylinders operated when a service brake application was made?

A.—It would indicate that the brake was working in undesired quick action.

974. Q.—What is usually the cause for undesired quick action?

A.—A restricted service port in the equalizing slide valve, a restriction in the port leading to the application chamber or a broken release piston graduating spring.

975. Q.—What might be wrong if the brake fails to release after a service brake application?

A.—The pressure chamber of the control valve reservoir may be overcharged, the port leading to the application chamber closed or the hand brake may be set.

976. Q.—What could cause a failure to release accompanied by a blow from the application chamber exhaust port?

A.—It may be due to a badly leaking application piston packing ring which, with a considerable amount of friction in the application portion of the control valve, may permit service reservoir pressure to pass the piston and maintain the pressure in the application chamber and thus prevent a complete or prompt release of brakes on the car.

977. Q.—What would be indicated if the brake was very slow in releasing, and it was noticed that the escape of air at the application chamber exhaust port was very weak?

A.—It would indicate a restriction in the port leading from the release slide valve seat to the application chamber exhaust, possibly the restriction would be in the release slide valve ports.

978. Q.—What is the first thing that should be noticed when any disorder of the brake is manifested?

A.—That all of the exhaust ports are unobstructed.

979. Q.—What two exhaust ports being plugged would prevent the release of the brake after a service reduction?

A.—The application chamber exhaust port or the service brake cylinder exhaust.

980. Q.—What would cause a blow at the service brake cylinder exhaust port while the brake is released or with the control valve parts in release position?

A.—A leaky application slide valve or a leaky emergency slide valve.

981. Q.—What would cause a blow when the brake is applied in service or emergency?

A.—A leaky exhaust valve of the application portion.

982. Q.—What could cause a blow at the emergency brake cylinder exhaust port?

A.—A leaky emergency slide valve or a leak past the cap nut of the quick action closing valve when the control valve is in release position.

983. Q.—Where could the blow be from if the brake is applied in emergency?

A.—From the emergency slide valve, or from a leaky application piston packing leather or past the seal at the brake cylinder side of the application piston.

984. Q.—What would cause a leak at the quick action exhaust port with the brake released or applied in service?

A.—A leaky quick action valve seat.

985. Q.—Where could the leak be from if the brake was applied in emergency?

A.—By the failure of the quick action valve to release or from the seal of the quick action closing valve.

986. Q.—What could cause a blow at the application chamber exhaust port?

A.—A defective seal or leak from either the equalizing slide valve or graduating valve, from the release slide valve or graduating valve from the gasket between the graduated release cap and the body of the valve.

987. Q.—Where would the leak be from if the brake was applied in service?

A.—From a leaky release slide valve.

988. Q.—What would cause a blow at the reduction limiting chamber exhaust port when the brake is released?

A.—A leaky equalizing slide valve or graduating valve of a leak in the application cylinder cover gasket.

989. Q.—Where would the latter leak be from?

A.—From the service reservoir volume.

990. Q.—What could be wrong if the leak from the reduction limiting chamber exhaust port existed only when the control valve is in service position?

A.—It would indicate that the leak was from the cap nut of the application portion.

991. Q.—Where would this leakage be from?

A.—From the brake cylinder volume.

992. Q.—What would be indicated if the leak only occurred after the valve was in over-reduction or emergency position?

A.—It would point to a leaky emergency reservoir check valve.

993. Q.—What else could cause the leak when the valve is in emergency position?

A.—The leaky equalizing slide valve or graduating valve.

994. Q.—What would cause a leak at the emergency piston exhaust port?

A.—A leaky release slide valve or graduating valve, a leaky equalizing slide valve or from either of the leather seats at the small end of the equalizing piston or the small end of the emergency piston.

995. Q.—How would a test be made to locate the source of the leakage?

A.—The brake would be applied with a service application, if the leakage stopped it would indicate one of the leather seats was leaking, but if the blow continued it would indicate that the release slide valve was leaking.

(*To be continued*)

The Cummins Bill

R. S. Lovett, chairman of the Union Pacific system, commenting on the Cummins bill, which has been passed by the Senate, and referred to the lower House for consideration, approves of the means provided for the first settlement of all labor disputes through tribunals created by the bill; and, this done, it prohibits strikes under severe penalties by provisions that are undoubtedly consistent with the Constitution. The Association of Railway Executives has taken no position upon this question, because it relates to disputes between the companies and their employes, and it is for the public to determine what measures it will take, and how far it should go, in protecting itself against the results of such disputes, in the form of strikes or otherwise.

The Cummins bill also contains elaborate provisions with reference to the merger or consolidation of the railroads of the country into from twenty to thirty-five competing systems—voluntarily for seven years, and therefore compulsory. Mr. Lovett does not believe the plan is workable, but as its operation is not immediate and as experience and time will demonstrate its defects before the plan becomes obligatory, it is not necessary to discuss it at this time. Mr. Lovett also disapproves of the proposition that railroad owners shall not be entitled to the earnings they may be able to save out of the rates which the government itself prescribes. The bill proposes to confiscate all the railroad companies earn in excess of six per cent, thereby seizing upon all the rewards of wisdom in investing and efficiency in operation. All that is necessary is that the railroads should receive as fair treatment as that employed in other necessary enterprises.

Some First Principles of Arc Welding With Metal Electrodes

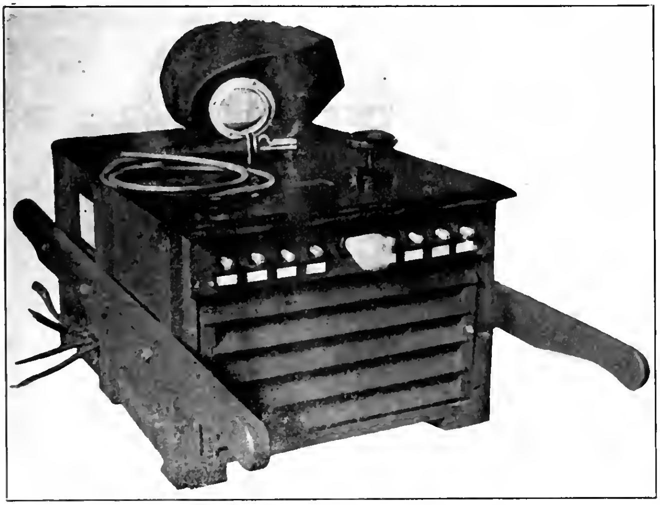
By J. F. Springer

One of the principal systems of electric welding uses a metal hand electrode. The arc is formed between the tip of this electrode and the work. The electrode may be bare or it may be coated. The arc is created by touching the metal tip to the work and then withdrawing it. It consists of various materials. First, there is a stream of metal particles of the same kind as the metal of the electrode. These constitute an incandescent vapor. If the metal of the electrode is not pure, or if it is coated with metallic and other substances, there will, naturally, be additional vapors in the arc. Furthermore, as the arc stream is surrounded by the atmosphere, itself a mixture of oxygen, nitrogen, carbon dioxide, etc., one is to expect the central stream of the arc to be enveloped by gaseous substances formed by chemical reactions between the surface of the central core and the surrounding atmosphere. In short, the arc consists of a central core and an enveloping sheath. The *core* is made up principally of metal vapor, the metal being that of the electrode. The *sheath* consists of vaporized oxides.

The sheath protects the core from the action of the atmosphere—particularly from the action of the free oxygen in the atmosphere. This is a very important matter which the reader will do well to master.

The metallic particles in the central stream are passing from the electrode to the work. They constitute the source from which the new material in the weld is built up. If the metal of the electrode is impure, then the deposit made upon the work will naturally include more or less of the impurities. This means that one is not to expect better metal in the weld than was in the electrode. As a matter of fact, the weld may easily consist of worse material. This may, perhaps, need a word of explanation.

Metal vapors are highly responsive to the action of free oxygen, such as that in the atmosphere. Consequently, if the central core of an arc becomes exposed to the air, there will naturally be oxidized metal in the deposit which constitutes the weld. If the electrode is steel, it will of course contain carbon. This carbon is also responsive to oxygen. In the steel, the carbon was in the form of iron carbide (cementite), which is, when cold, in the solid state. But the two combinations of carbon with oxygen are gases—carbon monoxide and carbon dioxide. Now the iron and other metallic oxides may be expected to be present in a weld formed by the central core of an arc that has suffered exposure by the rupture or dislocation of the enveloping sheath. The natural preventive is the maintenance of the protection afforded by the envelope of gaseous materials, which of course, arise spontaneously.



PORTABLE ALTERNATING CURRENT APPARATUS.
Electric Cutting and Welding Co., Newark, N. J.

THE SHORT ARC

Perhaps the best safeguard against rupture or dislocation of the sheath is the maintenance of a *short arc*. It is often very easy to stretch the arc out to a good length. One begins an arc by actual contact with the work and then, more or less gradually, develops the length by withdrawing the electrode. A long arc is susceptible to derangement of the relative positions of the core and the sheath. The sheath may, for example, suffer deflection by reason of an air current or draft. This air current may be a natural movement of the atmosphere, due to the opening or shutting of a door or to a gust of wind entering an open window; or else to an artificial movement brought about by the high temperature at the arc. The natural currents may be guarded against by shutting off possibilities of stray gusts and the like; but the artificial ones can hardly be dealt with so easily. However, a short arc is effective in minimizing the exposure due to the deflection of the central core and the protective sheath from their proper relative positions. If the welder is alive to the disadvantages of such deflection, he may then do his part by manipulating the electrode.

THE HUMAN FACTOR

As the welding goes on, the metal electrode diminishes in length—naturally, too, since the material for the weld comes from the electrode. With regular operation, the shortening of the electrode may be expected to be regular, too, but the conditions will often undergo changes which will make it difficult or even impossible for the workman to maintain an even loss of material from the electrode. In short, the irregularities of conditions will tend to create a problem for the operator. Naturally, then, the result will be a varynig length of arc, as one can not expect the workman to give instantaneous and perfect response to varying conditions. It will be well for the operator to keep steadily in mind that he must maintain a short arc.

MATERIAL IN ELECTRODE

Mild steel is one of the chief metals which the operator will have to weld. The question arises whether it may not be advisable to use some particular material for the electrode when mild steel is to be the work. One of the large manufacturers of arc welding apparatus—that is to

say, a large concern interested in giving correct information—recommends for the electrode a low-carbon steel conforming to the following specifications:

SPECIFICATIONS FOR ELECTRODES TO BE USED ON MILD STEEL

Carbon	trace to 0.25%
Manganese	trace to 0.90%
Phosphorus	not more than 0.05%
Sulphur	not more than 0.05%
Silicon	not more than 0.08%

"The composition of the mild steel electrodes, commonly used, is around 0.18 per cent carbon, and manganese not exceeding 0.50 per cent, with only a trace of phosphorus, sulphur and silicon." The sizes most in use are ⅛, 5/32 and 3/16 inch diameters. Electrodes of the foregoing character are supplied by such concerns as

John A. Roeblings Sons Company, Trenton, N. J.

American Rolling Mills Company, Middletown, Ohio.

American Steel & Wire Company, Pittsburgh, Pa.

Ferride Electric Welding Wire Company, New York City.

Page Woven Wire Company, Monessen, Pa.

John Potts Company, Philadelphia.

SELECTION OF SIZE OF ELECTRODE

The choice of size is controlled more or less by the thickness of the work at the welding location. In general, the diameter of the electrode will be less than the thickness of the work. For example, plates having a thickness of 3/16 inch may properly be welded by wire ⅛ inch diameter, and plates 1 inch thick by wire 3/16 inch diameter. But for plates only 1/16 inch thickness, wire having the same diameter may suitably be used.

STRENGTH OF CURRENT

The *voltage* required for a short arc, bare electrode, may be no more than 22 volts or thereabouts. If the electrodes are coated, the voltage required for a short arc may not exceed 35 volts. But, naturally, there will be variations, due to changes in conditions. Thus, a film of foreign matter may impede greatly the passage of the current.

The *amperage* will depend upon the work in hand and the diameter of the electrode being used. For example, with plates ¾ inch thick and an electrode 3/16 inch diameter, an amperage of 150 to 200 may be properly used. For comparatively thin work—say, sheets ⅛ inch thick and an electrode diameter of 3/32 inch, the amperage may properly vary between 50 and 85 amperes.

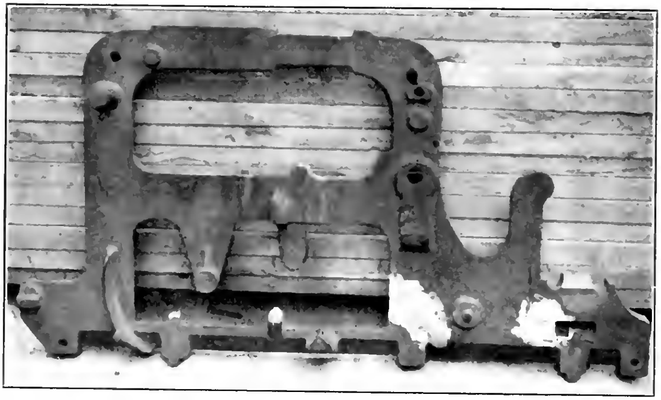
COST OF CURRENT

Knowing the average voltage and the average amperage, one may assume the average current as having a kilowatt strength obtained by multiplying the volts and amperes together and dividing by 1,000. This is a very simple rule, and gives one a guide as to expense. It is based on the principle that in any electric current, the number of watts is equal to the product of the number of volts by the number of amperes. After one finds out how many watts there are, the number of kilowatts is naturally gotten by dividing by 1,000.

Suppose, for example, that we assume that the voltage for a short arc will average 27 volts; and that, the work being sheets ⅛ inch thick and the electrodes having a diameter of 3/32 inch, the current will have to amount on the average to 63 amperes. With the volts at 27 and the amperes at 63, the watts are readily determined by multiplying these two numbers together. Doing this, one obtains 1701 watts. This means 1.701 kilowatts. We now have the result that the work of welding these sheets can probably be done with a current having the strength of 1.701 kilowatts; so that the cost will now depend upon the length of time the current needs to be maintained.

If the work continues for 1 hour, then the amount of current consumed will be, naturally, 1.701 kilowatt-hours. The cost will now be easily gotten, if one knows the price of current per kilowatt-hour. This varies from city to city and shop to shop. At 5 cents a kilowatt-hour, the job will cost for current 8½ cents; at 7½ cents a kilowatt-hour, 12¾ cents; at 10 cents a kilowatt-hour, 17 cents.

There are opportunities to waste current between times, when no actual welding is going on. If the current is shut off at such intervals, a saving in the cost of electricity will of course result.



A WELD MADE BY A PORTABLE ALTERNATING CURRENT APPARATUS.
Electric Arc Cutting and Welding Co., Newark, N. J.

What Is Meant by Percent Grade.

In railroad work the term "percent grade" is very commonly used. We know it is the ratio of elevation to distance traveled, but the question immediately arises as to whether the distance should be measured along a horizontal line or along the roadbed. If reference is made to handbooks, statements can be found in some which will give the percent grade as the ratio of the distance the train is raised to the distance traveled along the roadbed, while others will state that the percent is the number of feet vertical rise in a horizontal distance of 100 feet.

The different and conflicting statements depend upon the point of view. To the civil engineer the second definition is the one used and is the correct and true definition. However, the first is used practically in railroad calculations, as on grades found in railway work the ratio of the vertical rise to the distance along the track is not materially different from the ratio of the vertical rise to the horizontal distance. Grade resistance is then 20 lbs. per ton weight for each percent grade.

The Fastest Trans-Continental Transportation.

From recent well authenticated reports it appears that the new Canadian Pacific transcontinental de luxe train, the Trans-Canada, Limited, makes the fastest connection between the Atlantic and Pacific, accomplishing the journey in less than four days. There are thirty-one stops in the 3,000 miles run. The rolling stock for the new service is valued at six million dollars. It includes twenty-four locomotives, fifty-nine sleeping cars, twelve observation cars, fifteen dining cars, twelve baggage cars and five compartment cars.

Electrical Department

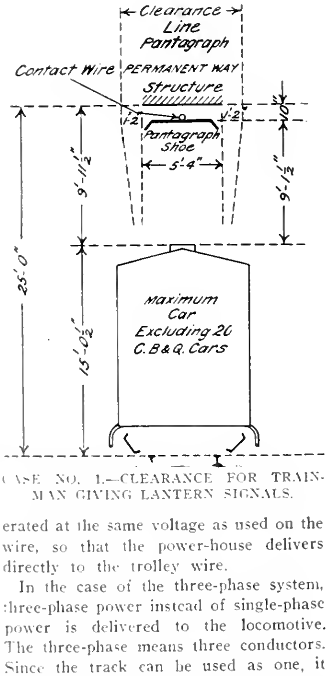
Railroad Electrification—Testing Polarity of Motor Field Coils

We pointed out in the preceding article the advantages of electrification and the benefits to be gained by the use of electric operation. The electrical design of the locomotive will depend somewhat on the electrical system with which it is to be used. There are, as we know, two main electrical systems, namely, the Direct Current System and the Alternating Current System. The direct current system varies from 600 volts up to 3,000 volts on the conductor. The alternating current system varies in voltage from 3,300 volts to 15,000 volts, and may be either three-phase power supply or single phase.

The method used to collect the electric power from the conductor, to operate the locomotive, depends on the system and the voltage. Street railways first used electric power for transportation. The electric power was supplied to the cars through an overhead trolley wire, carrying 500 volts direct current. As more and larger cars were operated, the single overhead trolley wire was not of sufficient size to carry the current economically, so that copper feeders were installed in parallel with the wire, and taps were made at frequent intervals onto the trolley wire. When steam railroads operating heavy train service were electrified with 600 volts, the power demanded by the trains would be greater than could be delivered by the wire, so that the third-rail contact system was used to give the necessary current-carrying capacity.

In a typical direct-current system, the power is generated at a central powerhouse as alternating current. It is transmitted out as high voltage, three-phase, to various substations located along the line. At the substations this three-phase power is reduced by transformers and then changed by rotary converters into direct current for the third-rail supply. The current taken from the third rail and used by the locomotive is ordinarily returned back to the substations through the running rails. In the case of heavy traction systems the voltage drop in the rails may be excessive, so that copper cables, known as negative feeders, are connected in parallel with the rails to reduce the drop. The third-rail system of 600 volts has its limitations. In dry climates, with sandy soil, 1,200 volts can be used on the third rail, but due to the danger of using 1,200 volts on a third rail, and due to the few places it could be used economically, it may be said in general that this system of electrification is one of 600 to 700 volts. The power delivered is the product of amperes (current) times volts, so that where heavy train service exists, the current will be enormous with only 600 to 700 volts because the horsepower demands will be high. Heavy drafts of current means abundance of copper, many substations, etc. To eliminate the excessive copper and many substations a light voltage was required, and subsequently the overhead contact system was employed, using high voltage, single-phase, or three-phase current, and recently high voltage direct current.

In the case of the single-phase system, the power is transmitted at high voltage to the transformer substations, where it is transformed down to the workable voltage and connected to the overhead contact wire, or the voltage may be generated at the same voltage as used on the wire, so that the power-house delivers directly to the trolley wire.



CASE NO. 1.—CLEARANCE FOR TRAINMAN GIVING LANTERN SIGNALS.

In the case of the three-phase system, three-phase power instead of single-phase power is delivered to the locomotive. The three-phase means three conductors. Since the track can be used as one, it necessarily follows that two contact wires insulated from each other must be placed above the track. There is much complication in the stringing of these wires and in the arrangements at crossovers, etc., so that there has been only a small mileage of three-phase electrification compared to the other two systems.

The high voltage, direct-current overhead system is similar to the low voltage direct current third-rail system, in that the power is transmitted in the same way and converted by rotating machinery. The power is fed to an overhead conductor instead of a third rail.

Electric locomotives can be classified under two headings: (1) those equipped with pantagraph trolleys to collect the current at high voltages from overhead wires located several feet above and directly over the track, and (2) those equipped with third-rail shoes to collect the current from conductors located alongside of and adjacent to the running rails.

It is interesting to consider the construction and location of the electric conductors—namely, the overhead trolley and the third rail.

In either case, the conductor must be insulated to prevent the electric current escaping or "leaking," and must be so located with position of the track that there will be the minimum interference with existing structures; that there will be no interference with the rolling equipment and that it will permit of safe and satisfactory operation of the locomotives.

Considering first the overhead conductors, the American Electric Railway Engineering Association has recommended certain clearances. Table 1 tabulates data for five different cases and takes into consideration the clearance necessary where the trainmen are required to give signals by hand and by lantern. These conditions determining the height of the trolley wire above the top of the running rails. It is of advantage to keep the maximum height of the wire below 24 feet. As the height is increased the pantagraph collector must become larger and larger to take up the distance from the top of the locomotive to the wire. The height of the locomotive roof is limited to the clearance diagram of the

	Case 1	Case 2	Case 3	Case 4	Case 5
	Clearance for trainmen giving		Normal minimum clearance without trainmen on cars	Special minimum clearance for voltage poles without trainmen on cars	Minimum clearance for 600 V. D. C. overhead contact wires
Dimension	Lantern signals	Hand signals			
Distance between wire or face of contact rail and structure	0' 10"	0' 10"	0' 10"	0' 10"	0' 9"
Desirable clearance between rolling stock and wire, or contact rail	......	......	2' 1½"	0' 11½"	0' 2½"
Reach of 6-foot trainman	7' 8"	7' 8"	......	......	......
Lantern, Height of	1' 0"	......	......	......	......
Clearance	0' 5½"	0' 5½"	......	......	......
Total clearance above car	9' 11½"	8' 11½"	2' 11½"	1' 9½"	0' 11½"
Height of car	15' 0½"	15' 0½"	15' 0½"	15' 0½"	15' 0½"
Height of permanent way structure	25' 0"	24' 0"	18' 0"	16' 10"	16' 0"

road. Cases 3 and 4 show the normal minimum clearance and the special minimum clearance.

When the locomotives are running at high speeds there is a certain swaying of the pantagraph. The clearance lines take this sway into consideration. Moreover, the body of the locomotive also moves, which is transferred to the pantagraph. For instance, the locomotive springs may have a maximum difference in height of 1 in. The rails may be ½ in. difference in elevation. The total amount of swaying or movement of the pantagraph will depend (as clearly seen) on the height of the wire. The width of the shoe, 5 ft. 4 ins., depends on the total sway and is arrived at by considering the sway as 6 ins., either side, when the trolley wire is 22 ft. above the top of the running rails.

Testing Polarity of Motor Field Coils.

The use of electric motors in railroad shops has become very common. Many of these motors operate on alternating current, but there are many roads using direct current for traction purposes, so that direct current motors are not only used on the equipments, but in the shops as well. Electric motors, as any machine, require at some time an overhauling, due either to a failure or to the length of time the motor has been in service. In this overhauling the field coils should be removed, painted or perhaps reinsulated and then replaced in the frame. It is very important that these field coils be replaced and connected correctly, as faulty operation of the motor will be experienced, if a field coil is placed on the pole, upside down. Practically all of the newer motors are fitted with interpole fields in addition to the main fields. Not only must the main fields be connected correctly, but also the interpole fields and there must be a proper relation of polarity between the two sets. With the coils connected incorrectly, the armature may run hot, due to an unbalanced magnetic field, the commutation may be poor, and flashing may result in an interpole motor because of a reversed interpole coil.

After all of the field coils are assembled in the frame they should be tested for polarity. Only a small amount of a simple apparatus is required to make the tests. The fields are connected in series, as shown in Fig. 1. Resistance should be placed in series with the power supply so as to cut down the amount of current flowing through the fields to a safe value, but strong enough to energize the fields and magnetize the poles. When the switch is closed current passes through the field coils. Take a compass and hold in front of each pole, or to the pole stud bolts on the outside of the frame and the compass should reverse at alternate poles. That is, the No. 1 pole will attract the north point, the No. 2 pole the south point, the No. 3 pole the north point and the No. 4 pole the south point. If these conditions should not exist the winding connections or the coils must be changed.

On the motors equipped with interpoles two separate tests should be made, one in the main fields as described above and one on the interpole which is made in the same manner and as shown in Fig. 2. It is important to have the proper relation of polarity between the main poles and interpoles. Connect up the motor, place armature in frame and note rotation of the armature. The polarity of a main pole should be the same as the polarity of the interpole next to it in a clockwise direction when facing the commutator end of the motor.

In making the tests certain precautions should be followed.

Hold the compass so that it is free to move and in a horizontal position; test

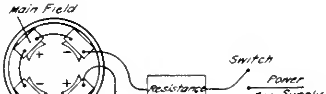


Fig 1.

POLARITY TEST ON MAIN FIELD

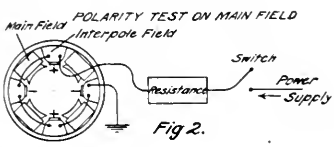


Fig 2.

the polarity all from the same side, in the commutating or pinion end, whichever is more convenient. Remember it is not necessary that a certain pole is of a definite polarity, but it is essential that the adjacent poles shall be different.

If a compass is not available a polarity detector can be easily made. Take a piece of steel wire about 3 inches long. Touch one end to a field pole when it is magnetized and hold there for a few minutes. The piece of wire becomes magnetized one end N and other S. By making a loop at one end the ends can be distinguished. The indicator is completed by suspending at the middle by a short thread.

Association of Engineers.

The American Association of Engineers has obtained results on four regions of the United States Railroad Administration. The Northwestern Region was the first to authorize the new schedule, and it was followed by the Central Western Region, and the Eastern and Allegheny Regions. Regional Director Bush, of the Southwestern Region, advises that he will have a representative confer with a representative of the Northwestern Region, and that he will bring engineer employes in the Northwestern.

Notable Achievements of the Westinghouse Electric and Manufacturing Company.

With the placing in operation of the largest turbo-generating unit ever built; the delivery of the electrical equipment for what will be the world's greatest electric furnace installation; the breaking of the record for size in the construction of electric locomotives; the export shipment of the electrical apparatus for what will comprise the first electrically-driven steel blooming mill to be erected in the Far East; the completion of the design for a transformer of higher rating than of any that has yet been manufactured; the beginning of work on the installation of a hydro-electric generator of uncommonly high capacity, and many other successful achievements, the 1919 resume of the Westinghouse Company presents numerous outstanding features.

Not only have large-scale operations with standard apparatus been undertaken and successfully accomplished, but many new types have been brought forth and placed on the market. And the progress, in addition to developing along lines of increased capacity and higher rating, has proceeded in directions where a need for smaller size and a saving of space has arisen.

A notable installation is the 70,000 Kw., 25 cycle, three-element, cross-compound unit placed in service during the past year at the 74th Street Station of the Interborough Rapid Transit Company of New York City. The unit is rated at a capacity of 60,000 Kw. continuously, or 70,000 Kw. for two hours, and is, therefore, the most powerful prime mover in the world.

It has three elements, one high pressure and two low pressure, and it is the first triple cross-compound turbine to be placed in operation.

The purpose of this huge machine is to assist in meeting the greatly increased demand for transportation in New York City, due to the opening up of a new subway system, and the extension of the service of the existing subway, elevated and surface lines. The new unit occupies a floor space of 52 x 50 ft., and is about 19 feet high. The high pressure element receives steam at 205 lbs. gauge pressure, and superheated 150 degrees F., and exhausts it into the low pressure elements at 15 lbs. gauge pressure. The two low pressure elements are identical in construction, and each receives one-half of the steam from the high pressure element and exhausts it into the condenser, where a 29-degree vacuum is maintained. All three elements operate at 1,500 r. p. m., and each drives a generator rated at 20,000 Kw. continuously, 23,500 Kw. for two hours, and 30,000 Kw. for a half hour. The generators deliver three-phase, 25-cycle, 11,000-volt alternating current.

Details of Parts of the Pacific Type Locomotive as Shown in Our New Chart, No. 12

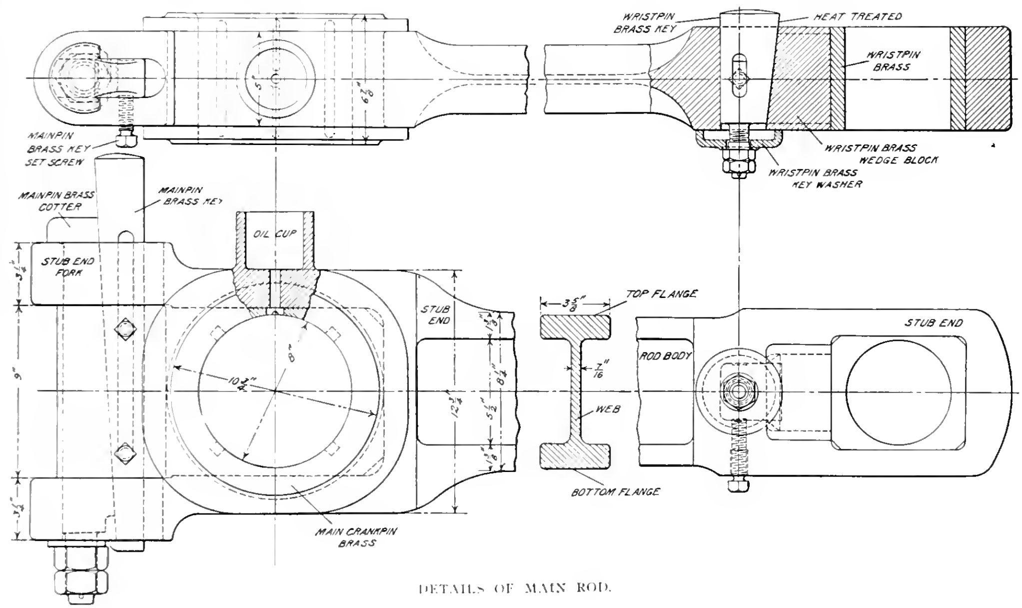
The illustrations of main and side rods shown herewith are of those designed for use on the Pacific locomotive that was used as the base for the chart of a locomotive of that type which has just been issued by Railway and Locomotive Engineering. Both rods are of the usual I section in accordance with present practice. The proportions of the section of the body show the final development of caring for the stresses imposed in the heavy top and bottom flanges and thin web. The wristpin brass is solid and is held in place by the wristpin brass wedge key has a lip at the bottom which will catch against the cotter and prevent it, the key, from being thrown out in case it works loose.

The main crankpin brass is split and can be adjusted by the key and cotters placed behind it. This arrangement makes an adjustment for length possible at each end of the rod. The main crankpin brasses can be filled and rebored, but the wristpin brass, being solid and subjected to comparatively little wear, cannot be refitted.

Heat treatment is applied to the main pin through two ducts, and in order that inspection may show whether the ducts in the rod come fair with those in the brass, and the latter has not turned out of place, a reference line is scribed on the side of the rod and the brass. The two brasses are thus mere solid bushings incapable of any adjustment in accordance with current practice.

The body of the rods are of T section with flanges $\frac{3}{4}$ in. and webs $\frac{3}{8}$ in. thick.

The knuckle pin has a bearing on its brass of 7 ins. in diameter, 2 ins. long. The pin is turned on a straight taper at



DETAILS OF MAIN ROD.

block and key. The block is held in place by lips upon the upper and lower faces, which move in corresponding gains in the stub end. The key is held by a stem with nuts bearing on the key washer and locked by a set-screw running up from the bottom of the rod. The wristpin stub end is of the solid forged loop type.

The stub end at the crankpin end is forked with the oil cup forged on and the split half brasses held and adjusted by the usual cotter and key. The lip of the former is held down against the top of the fork by nuts that are prevented from working off by a split pin. The key, after having been driven home, is held in place by two set screws through the separator piece of the rod fork. In order to prevent the key from being lost, the body of the rod, the main crankpin brass cotter, the main crankpin brass key and the wristpin brass key.

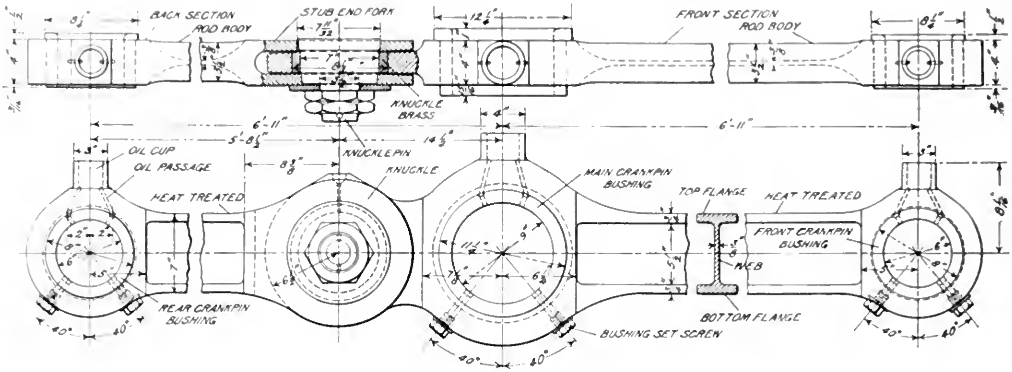
Lubrication of the main crankpin may be accomplished by the use of asbestos wicking soaked in oil, or grease may be used with a slightly different arrangement.

The side rods are of the usual form, and both front and back sections are heat-treated. The front and back crankpin brasses are 6 ins. in diameter and 4 11-16 ins. long on the bearing. They are 1 in. thick and are held in place by two dowel pin set screws, held by check nuts, which prevent them from bucking off. In addition to which the brasses are pressed in place by a screw or hydraulic press. Lubrication is carried down to the each end to fit in a straight taper hole in the two ends of the fork of the rear section of the rod, and the straight cylindrical bearing for the brass is turned between the two ends. The fork of the rear section is flared on the inside 1-16 in. between the seat of the knuckle pin and its end. This prevents any binding and springing of the end of the fork in case of any relative lateral motion between the rear and main crankpin, a motion that is sure to take place.

The knuckle pin brass is solid and is pressed into the tongue of the front section, with nothing but its own frictional resistance to prevent it from turning. This is, of course, quite sufficient, as the amount of motion on the pin is almost nothing, being simply that necessary to compen-

sate for the relative vertical movements of the three coupled wheels. Suppose, for example, that the two front wheels remain at the same height and the rear wheel goes into a soft spot with a depression of ⅜ in., the peripheral motion on the knuckle pin would be only 0.0019 in., a truly negligible quantity, but one for which allowance must be made in order to prevent undue strain being put upon the rod. Naturally, with such a small amount of motion to be cared for, the lubrication can be correspondingly slight and this is provided for by a single oil hole through the tongue and brass with a small cavity at the top to hold the lubricant.

The main crankpin brass is also a solid bushing and is held by two dowel set-screws, the same as the end pin brasses, and is lubricated in the same way. It has a bearing 9 ins. in diameter and 5 15-16 ins. long, and is 1⅛ ins. thick. All oil holes for this and the end brasses are ⅜ in. in diameter. Positive nut lock washers are used to hold all of the dowel pin set-screws. The knuckle pin is held in place by check nuts, and these are prevented from backing off by a split pin in the usual way.



DETAILS OF SIDE RODS.

Thoughts on High Speed Steel

For several years past the locomotive and car superintendents of the railroads of the world have been paying particular attention to increasing the speed of trains and the improvement of their engines and cars. Rules which had formerly been regarded as having been established on fixed principles beyond all peradventure, have been taken up and subjected to a critical discussion. Every advance has been made tentatively and cautiously, because it has been impossible to effect a sicentific demonstration of what would occur under changed conditions.

In the textbooks calculations have been made of the proper coning to be given to the wheels, of the proper play against the rails, of the deflection of the latter, and all by means of very elementary formulæ; it has been shown that the dimensions thus obtained give a smooth even movement over the rails without skidding and with no friction of the flange against the rail head worth speaking about. The question of accuracy arose, and the methods of settling it. Attempts have been made to calculate the actual movement of the wheel and rail, but for this work it becomes necessary to pay particular attention to the friction that is developed between the flange and the rail head; though the laws of friction are not yet thoroughly known. In a few simple problems of machine construction, the rules given by Conlomb and Morin can be utilized; and this is done in other cases where it is well known that they are wrong, but will not cause an appreciable error. But in the matter of the wheel and rail under consideration, the circumstances are entirely different from those existing in the classic experiments just mentioned; the co-efficient of friction undoubtedly changes about this point of contact and varies at every instant with the condition of the track and other environments; in a word, we are in the presence of a problem of which there are no known elements.

Observation has, however, shown us some simple things; the locomotive and car always stand diagonally across the track when rounding a curve; the truck bears against the inside rail with the flange of the second or third wheel, and impinges agains the outside rail with the flange of the front wheel. This always holds good and cannot be changed by giving a super-elevation to the outside rail; for whatever that may be made, the outer rail is always impinged by the front wheel. Or, it might seem as though all of the accepted theories regarding the movement of cars on railroad tracks must be remodeled, since a French engineer has recently demonstrated to his own satisfaction that all of the arrangements intended to assist in the running of curves are absolutely detrimental. He even made experiments to determine whether there is any necessity for the elevation of the outer rail, and asserted that, in most instances, it is actually injurious.

The exception wear, which affects the front wheels, has led engineers to try and give the leading axle a radial position. This has been done more extensively in Europe than in this country.

For a long time it was considered that the problem was purely geometrical and attempts were made to secure a combination by which each group of axles should be brought to an approximately radial position; and there was a lookout for a simple mechanism so proportioned that the distortions of the car or engine on the track would disappear. The best solutions of the problem lie in the Bissel radial boxes and the pony truck. The general plan upon which radial boxes work is that of inclined planes that are geared, sometimes springs bearing against the boxes are used to push the axle that has been temporarily crowded out of its normal position, back into its place after the curve is passed. These systems may be considered as the means by which the front part turns the engine and leads it around the curve. Thus far we have been speaking of a single leading pair of wheels. But the American four-wheeled bogie truck is, without doubt, the best device that has been used for the front end.

Again, we must remember that the rails do not offer a perfectly smooth and even highway. They are not like the ways of a planer, but are very uneven surfaces. On a straight line the locomotive whips from right to left under the combined influence of the vibrations caused by its own mechanism and the unevenness of the track. The deflection of the rails is never the same on the two lines of rails; the axles do not run in a horizontal line, but bend continually from one side to the other, causing a constant rotation about continually changing vertical axes.

We cannot take the rigid rails of the shop and the pit as a basis, but we must build our engines and cars so that they can run easily over the rails that are continually bending, that have no regular form, but which have periodical interruptions to an even deflection. Hence the designer must not only consider the problems involved in the proper rounding of curves, but the general movement over unstable supports.

It is, therefore, evident that it is too much to expect a geometrical regularity, since the given conditions are devoid of any determinable law; but we can acquire a semi-periodical regularity and a practical sufficiency.

It may not be out of place to refer, just here, to the experiments of Bernouilli with a long pendulum hung from a short one, from which he determined that if two oscillating bodies are connected to each other the influence of the motion of the carrier over that of the carried decreases as the time of the oscillation of the first is less than that of the second.

The arrangement of the bogie truck on American engines and cars of good design is most admirable; it has small wheels, a short wheelbase, very flexible springs which permit it to roll in the most natural way over rough tracks, and finally the frame is suspended to the truck by a swing motion whose oscillations are comparatively slow. The principle laid down by Bernouilli is thus especially applicable to English engines and to American engines and sleeping cars, since the centers of gravity are usually quite high.

There seems, on the other hand, to be an ever-present fear in the minds of European designers lest the engine should overturn, and in order to avoid such a disaster the center of gravity is lowered as much as possible. The result is considerable embarrassment in the construction of high-speed machines; they must have large wheels, yet they avoid raising a large boiler well up into the air; so they drop the boiler down between the wheels, and these locomotives which should be very powerful have smaller boilers than many freight engines.

English and American designers have been bolder and some have even maintained the proposition that stability is increased by raising the center of gravity. In point of fact, the word stable has a double signification: the engine must not upset, but it must also be adapted for running over an uneven track. There is another quality which is often confounded with stability because the engine is easy running, seems well balanced and inspires a sense of security in those who ride upon it. This may be called good running or easy riding and is a very important quality. For good running or easy riding two qualities are required: the oscillations should be short; the time of the oscillations should be long. These two conditions are unreconcilable when considered as a spring whose period varies as the square root of the deflections, but they are quite possible when the weight is considered as suspended like a pendulum.

Car builders have used the principle more widely than the builders of locomotives, because the first requirement which is laid down for them is: "Secure the comfort of the passenger." Here, as in many other circumstances, we find the application of a well-known law which governs all advance: "The principle is formed from its component parts."

It seems strange to us, but designers in Europe have for so long a time apparently failed to grasp the advantages of our bogie, for those which they have heretofore constructed have hardly been built so as to obtain the best results on curves; also, they do not seem to understand either the remarkable properties which it possesses for steadying the motion on a straight line.

It would hardly be right to pass by the subject of high-speed locomotives without a word regarding electricity.

The mechanism of the locomotive still remains in a sort of primeval condition; the reciprocating motion of the pistons and the connecting rods induce a series of disturbances which cannot be satisfactorily avoided. We do not say that the problem is insolvable, but superintendents of motive power are exceedingly averse to the use of anything that will tend to complicate the locomotive; this may be a strain that serves as a check to advancement and was the cry that was raised against the compound for a long time; yet we do not hear it today. When simplicity is involved we call up an old metaphysical standard of judgment, whereby that which is perfect is simple. But this point of view should be abandoned by practical men, for whom perfection should consist in regularity of movement and good-working engines. The locomotive as built does not entirely fulfill these conditions.

In this the electric motor has the advantage. Its construction is almost ideal: Steam is used in a stationary engine; the motive power is communicated to motors on the axles, and it is not among the impossibilities of the future that in spite of the double transformation of power it may be more economical than the present locomotive. When regarded in tne light of its evenness of motion it is far superior to anything of which we have any conception in the form of a steam engine.

High speed brings up a multitude of other considerations: Among other things, it is very essential that the engine should be capable of running long distances without stopping or appreciable lessening of speed. The first can only be accomplished by careful arrangements looking towards a husbanding of water; numerous attempts have been made to avoid the apparently useless pouring of immense quantities of steam into the atmosphere, by utilizing it for the feed; but they have none been remarkably successful and our resource is the track tank. To avoid slackening speed in passing depots, it is necessary that there should be some modification in all from their original arrangement. In this respect the New York, New Haven & Hartford Railroad are probably leading all the roads of this country, by the radical changes in their stations and highway crossings. They have built bridges until there is hardly a grade crossing between New York and New Haven. Trailing switches are used and it is safe to run from end to end of the division without a slackening of the speed.

Very few people appreciate the difficulties arising from the bad condition of the track. The rails must necessarily suffer from the passage of freight cars, whose wheels are often badly worn, and the factor of deterioration is still further increased by the wheels of the freight locomotives. The great super-elevation which is used on curves, causes great disturbances as a result of the blows that are delivered by heavy trains running at a low speed. The maintenance of freight rolling stock in first class condition when it runs over express tracks is the utmost importance, especially if the high speeds already attained are to be further increased. This is a matter of importance, and one which has been greatly neglected. The general impression seems to be that when high speeds are desired, it is enough to perfect the high speed rolling stock; it is quite as necessary that the freight cars should be in such condition that they can run over the rails without pounding them out of shape; and this matter becomes of added importance as the load on these axles is increased.

It is not many years since ten thousand pounds was the upper limit of the weight on locomotive axles; now as high as from sixteen to eighteen thousand are in use,

while the running speeds are up to seventy-five miles per hour. Under such conditions very serious deformations are caused even in newly laid rails, so that it becomes more than ever necessary to have rolling stock that will have an even motion in spite of the roughness of the track. In short, everything in the nature of the materials and the external circumstances seem to conspire against the realization of exceedingly high speeds, and attention must be given to every detail from the construction of the track embankments to the ornamentation of the locomotive and cars. Every disturbing element must be removed as far as possible, but the removal of them all is beyond the range of present human possibilities.

Proper Inspection of Tools Used in Shops.

From an address on the inspection of tools in railroad repair shops, delivered by G. L. La Fountaine, Safety Supervisor, Great Northern Railroad, at St. Paul, Minn., recently, it appears that the government records showed that in one year fifteen railway employes were killed and fifteen thousand two hundred and ninety-six were injured while using hand tools, and among these the shopmen were the heaviest sufferers. The only means of reducing to the lowest possible minimum this ever-present source of accidents is by a well defined and carefully planned method of inspection of tools.

Every shop or engine house employing any considerable number of workmen should maintain a tool room in which all hand tools of general use should be assembled at the close of the day's work. A competent man should be placed in charge of this room with the care and inspection of those tools as his sole duty; he should maintain his stock in a good, serviceable condition at all times, and any tools worn to any appreciable degree, such as a chisel with a burred or mushroomed head or a wrench with rounded jaws, the further use of which invites one of those minor accidents, should be repaired or replaced at once. It should be impressed upon this man that the primary purpose of his being employed is in the interest of Accident Prevention, and that the responsibility for any accident resulting from the use of a worn or defective tool which left the tool room in that condition must lie directly with him. We all know from experience that the average workman becomes calloused to repeated warnings and cannot be relied upon to inspect his own tools, but by thus making one individual responsible for their proper inspection, we shall have done much toward reducing our minor accidents.

In respect to those tools regularly assigned to shop employes, the greatest difficulties are encountered. These tools are kept in private lockers, and in a great many cases are subject to no other inspection but that of the employe himself. Although he may be known to be a conscientious and thoroughly dependable workman, his tools have been gathered during a long period of selection and he regards them with not a little pride. They have served him long and well, and he regards the inspection which may question their further serviceability as an intrusion. He may be perfectly aware of their little imperfections, but is loath to replace the old with new, feeling that the tool that he may get in exchange will not be to his personal liking. While it is true that he may continue using his old tools to the end of his working days with never a mishap, the chances are strong that sooner or later one of those imperfections of the tool will result in an injury to the user.

In this ever-present possibility of accidents that demands attention, and to meet that possibility there must be frequent and thorough inspections. Since the majority of workmen cannot be relied upon to inspect their own tools, that duty must devolve upon the shop foreman. Here again, of course, safety depends upon the attitude of the individual. The foreman can accept that duty in its higher light, as an opportunity to render real service to those in his charge by removing potential danger in the form of imperfect or worn tools, or he can accept that duty as an unpleasant task to be performed with the least possible inconvenience to himself.

The foreman can make the most effective inspection of tools while they are in actual use because of the opportunity this affords him tactfully to demonstrate and explain the elements of danger in the imperfection, thereby teaching the employe by example, as well as precept, which would leave a lasting and favorable impression upon him. This is much more desirable and productive of good than the inspection of the tools in each individual locker, as the latter method does not provide for the educational feature, which is of paramount value. Also such an inspection may be regarded by the workman as an intrusion upon his private property, even though such an assumption is entirely unwarranted. This inspection by the foreman might well be supplemented by a safety committee, such as now exists in nearly all well organized shops. Imbued with the proper spirit, the members of the committee could make frequent inspections of their fellow-worker's tools with their own daily experience as a guide. It may be added that the more recent reports showing a lessening of the number of accidents could be used as a text on which to make such pertinent observations as could not fail to carry conviction to the minds of reasonable men.

Domestic Exports from the United States by Countries During October, 1919—Steam Locomotives.

Countries.	Number.	Dollars.
Finland	15	375,000
France	1	4,100
Italy	75	2,372,000
Norway	12	405,754
Canada	1	13,500
Honduras	1	14,650
Mexico	1	35,000
Barbados	1	11,200
Cuba	9	151,392
Brazil	6	122,800
Peru	1	5,748
China	17	842,500
Japanese China	2	104,200
Chosen	3	129,500
British India	1	29,280
Straits Settlements	6	170,700
Japan	6	37,500
Russia in Asia	8	403.995
Australia	4	55,200
Total	170	5,284,019

Return of the Railroads.

As we predicted from time to time the railroads are to be returned to their owners.

So long as the President had not announced his intentions with the finality now expressed various interests have been able to insist, with or without real basis, that the President would not accept one kind of legislation or would insist on some other sort. They may indeed go on insisting, but they will have less capacity to worry the ten men who are trying to hammer the bill into the form in which it will become law.

The relation of labor to the railroad companies is conceded to be one of the difficult and dangerous features that the new era will have to face early. Because of this the provisions of the new law relating to dealings with labor are the center of greatest interest.

The House provisions have been criticized for setting up an elaborate mechanism for dealing with labor troubles, but placing nowhere a definite power to make and enforce orders. On the other hand the Cummins proposal of prohibiting strikes and setting up a tribunal with complete power is protested from the other side as certain to arouse the bitter antagonism of employes.

Senator Lenroot puts a reverse on the Cummins plan. Instead of forbidding strikes and compelling men to work he lets them strike and forbids them to work under certain conditions. He provides a scheme of conciliation with the necessary tribunal, but instead of giving it power to prohibit men from striking he authorizes it to make orders under which men who strike in violation of the tribunal's findings may not go back to work for a fixed period in the employ of any carrier in the country.

Items of Personal Interest

G. V. Booth, storekeeper of the Detroit, Toledo & Ironton, has been appointed general storekeeper at Jackson, Ohio.

P. E. Outerbridge has been appointed storekeeper of the Detroit & Toledo Shore Line, with headquarters at Lang, Ohio.

W. E. Harrison, master mechanic on the Erie at Kent, Ohio, has been appointed shop superintendent at Galion, Ohio.

F. A. McArthur has been appointed mechanical valuation engineer in charge of valuation of rolling stock of the St. Louis-Francisco.

Frederick H. Murray has been appointed master mechanic on the New York division of the Erie, with headquarters at Jersey City, N. J.

T. M. Bryden, having returned from military service, has resumed his duties as chief dispatcher of the Rock Island, with office at Pratt, Kan.

N. P. White has been appointed acting master mechanic of the Minnesota division of the Northern Pacific, with headquarters at Staples, Minn.

C. H. Tillett, acting signal engineer of the Grand Trunk at Montreal, Que., has been appointed signal engineer, succeeding R. F. Markell, resigned.

R. J. McComb has been appointed assistant to the president of the Q. & C. company, and is placed in charge of the Chicago office, People's Gas Building.

J. E. Willoughby, chief engineer of the Atlantic Coast Line at Wilmington, N. C., has been appointed chief engineer of the Georga and the Charleston & West Carolina.

F. H. Fechtig, purchasing agent of the Atlantic Coast Line at Wilmington, N. C., has been appointed purchasing agent of the Georgia and the Charleston & West Carolina.

Major C. E. Lester, having been discharged from military service, has been appointed supervisor of equipment under the Railroad Administration at Meadville, Pa.

F. C. Wallace, president of the Canadian Locomotive Company, has decided to continue as president of the company, but has been granted a six months' leave of absence.

P. H. Shay has been appointed storekeeper of the Lehigh Valley at Coxton, Pa., and R. E. Walker has been appointed to a similar position on the same road at Auburn, N. Y.

Fred Meyers, superintendent of safety on the Wabash, has been elected chairman of the steam railroad section of the National Safety Council, with headquarters at Washington, D. C.

Guy F. Egbers, having returned from service in the Russian Railway Service Corps, has resumed his former position as master mechanic on the Pasco division of the Northern Pacific.

C. E. Trotter has been appointed master mechanic on the Lake Erie & Western, with headquarters at Lima, Ohio, and T. J. Mullin has been appointed shop superintendent at Lima.

O. R. Anderson has been appointed division storekeeper of the Rock Island at Fairbury, Neb., succeeding T. Beard, transferred to the St. Louis division, succeeding M. C. Moles, resigned.

D. M. Pearsall, shop superintendent of the Atlantic Coast Line at Waycross, Ga., has been appointed superintendent of motive power, second and third divisions, with headquarters at Waycross.

W. C. Chambers has been appointed master mechanic in the Wabash, with headquarters at Decatur, Ill., and E. E. Sanford has been appointed assistant master mechanic, with office at Decatur.

William Greig, engineer at Anchorage, has been appointed assistant chief engineer of the Alaskan Engineering Commission, succeeding W. C. Edes, who retains his office as chairman of the commission.

A. McDonald, assistant to the superintendent of motive power of the Montreal shops of the Grand Trunk, has been appointed acting superintendent of motive power of the Montreal shops, succeeding E. R. Battley.

J. C. Kearney has been appointed roundhouse foreman on the Wabash, with office at Luther, Mo., and H. Oruburn, roundhouse foreman at Moulton, Ia., and W. E. Chambers, general foreman at Stanberry, Mo.

Otis R. Hale, formerly locomotive superintendent of the United Railways at Havana, has been appointed manager of the International Railway Supply Company of Cuba, with offices at Edificio Abreu, Mercaderes y O'Reilly, Havana, Cuba.

G. E. Anderson, formerly assistant to the vice-president of the American Locomotive Company, has been appointed assistant Eastern sales manager of the Duff Manufacturing Company, Pittsburgh, Pa., with headquarters at 30 Church street, New York.

R. H Turner has been appointed roundhouse foreman on the Rock Island at Topeka, Kan., J. H. Frey roundhouse foreman at Horton, Kan., and Frank P. Sullivan, general agent at Pratt, Kan., and James H. Bassett, roundhouse foreman at Elden, Mo.

R. W. Lipscomb, assistant superintendent of the Galveston, Harrisburg & San Antonio at El Paso, Tex., has been appointed chief assistant mechanical superintendent on the Southern Pacific Louisiana Lines and Texas Lines, with headquarters at Houston, Tex.

G. M. Lillis, locomotive engineer on the Denver & Rio Grande, has been appointed traveling engineer and train master of the Salt Lake division, with office at Soldier Summit, Utah, succeeding M. J. Ruland, who has been transferred to the Green River division.

R. Tawse, superintendent of motive power and equipment of the Detroit, Toledo & Ironton, with headquarters at Jackson, Ohio, has resigned to engage with the General Equipment Company, with headquarters at 808 American Trust Company Building, Cleveland, Ohio.

I. A. Uhr, inspector of electric signals on the St. Louis-San Francisco, with headquarters at Springfield, Mo., has been appointed signal engineer, succeeding R. E. Trout, resigned to become general manager of the Primary Battery division of the Thomas A. Edison Company.

Henry Blanchard, sales representative of the Baldwin Locomotive Works and the Standard Steel Company at Chicago, Ill., has been appointed manager of the new branch office at St. Paul, Minn., with offices in the Mercantile National Building, representing both companies, as formerly.

C. F. Greene has been appointed roundhouse foreman of the Rock Island at Wichita, Kan., succeeding F. P. Sullivan, promoted. D. P. Bonner, night roundhouse foreman at McFarland, Kan., and M. W. Lynch, assistant roundhouse foreman at Herington, Kan., succeeding J. Baker, resigned.

B. J. Peasley, master mechanic of the Vicksburg, Shreveport & Pacific, has been promoted to superintendent of motive power, and also of the Alabama & Vicksburg, and the Louisiana & Mississippi Transfer at Monroe, La., and J. F. Stanton has been appointed superintendent of car service at Vicksburg, Miss.

Paul M. Lincoln, commercial engineer in the employ of the Westinghouse Electric & Manufacturing Company, has resigned to enter the consulting engineering field and has organized the Lincoln Manufacturing Company, Cleveland, Ohio, which will be chiefly devoted to motor drive for various types of machines.

Charles Riddell, assistant secretary and treasurer in the office of the Baldwin Locomotive Works at Philadelphia, Pa., has resumed his former position as manager of the Chicago office, and Arthur S. Cole, manager of the Chicago office, has been placed in charge of the St. Louis, Mo., office of the Baldwin Locomotive Works.

John D. Rogers, formerly shop superintendent of the Virginia railroad, and latterly captain of engineers under the director general of military railways in Washington, D. C., having received his discharge from army service, has received an appointment on the foreign sales department of the Baldwin Locomotive Works at Philadelphia, Pa.

E. W. Smith, superintendent of motive power on the Central division of the Pennsylvania, with headquarters at Williamsport, Pa., has been transferred to the Eastern division, as acting superintendent of motive power, with headquarters at Altoona, Pa., and John R. Davis, general foreman of machine shops at Philadelphia, Pa., has been transferred to Altoona.

Henry Gardner, supervisor material conservation of the Baltimore & Ohio, with headquarters at Baltimore, Md., has been appointed corporate mechanical engineer, succeeding M. K. Barrnum. Mr. Gardner is a graduate of the Massachusetts Institute of Technology, and has had a wide experience in the mechanical departments of the leading railroads in the eastern states.

George D. Kimball has been appointed a member of the sub-coal committee, at Denver, Colo., of the Central Western region, representing the United States Fuel Administration. A sub-committee has been organized at St. Joseph, Mo., with jurisdiction over terminals at that point consisting of S. E. Stohr, chairman, and J. W. Bruce, who represents the United States Fuel Administration.

A. L. Crew, road foreman of engines on the Santa Fe Coast Lines at Los Angeles, Cal., has been appointed general road foreman of engines. Low Byers has been appointed road foreman of engines on the first district of the Arizona division at Needles, Cal., and C. C. Reynolds, road foreman at Needles, has been transferred to the third and fourth districts of the Los Angeles division at San Bernardino, Cal., succeeding J. C. Love, transferred to the third and fourth districts at Los Angeles.

W. B. Storey, federal manager of the Atchison, Topeka & Santa Fe, has been elected president of that road succeeding F. P. Ripley, resigned to become chairman of the board of directors. Mr. Storey has had an extensive engineering experience on the western roads. A graduate of the University of California, he joined the engineering staff of the Southern Pacific, and in 1893 was appointed assistant engineer with the United States Hydraulic Commission. In 1895 he became chief engineer and general superintendent of the San Francisco & San Joaquin Valley. In 1900 he was appointed chief engineer of the Santa Fe at Topeka, Kan., and in 1909 and 1910 he was vice-president in charge of construction, and latterly in charge of both construction and operation. When the railroads came under federal control he was appointed federal manager. He is a fine type of the energetic, accomplished western railroad man, and a worthy and fitting successor to Mr. Ripley.

Obituary

H. R. Stafford

Hal R. Stafford, chief engineer of the Franklin Railway Supply Company, New York, died of pneumonia at his home in Plainfield, N. J., on Dec. 9. Mr. Stafford was in his forty-second year and gave promise of a long life in his chosen sphere of activity. He began his engineering career with the American Locomotive Company at Schenectady, N. Y., and was particularly active in the development of the early types of Mallet locomotives, as well as many other important improvements in motive power developments. Latterly he accepted the position of mechanical engineer with the Economy Devices Corporation, and was appointed chief engineer of the Franklin Railway Supply Company when the latter company took over the Economy Devices Corporation. Among the engineering fraternity generally, and among railroad equipment constructors particularly, he was universally acknowledged to be in the front rank of his profession. In locomotive design and construction, looking towards the prime elements of safety, economy and capacity increasing factors, he has done great and good service and earned the respect, admiration and esteem of all who had the honor of his acquaintance.

Belgian Railways.

The shortage of rolling stock is still acute on the Belgian railways. The restoration made by Germany has not been sufficient to restore the railways to the pre-war conditions, as the equipment returned was usually found to be in a bad condition. Orders for 375 locomotives have been placed in the United States, 125 in Great Britain and 175 in Belgium. Part of the British stock has been turned over to the Belgians. At the time of the armistice 932 miles of the railways had been destroyed. Already all of this has been replaced. Of the bridges many of them are of a temporary kind. Heavy purchases of freight cars have been made, and the work goes on rapidly.

Railway Supply Manufacturers' Association.

The Railway Supply Manufacturers' Association and the Atlantic City Hotel Men's Association's executive committees met in a joint meeting with the general committee of Section III-Mechanical last month and decided to hold the convention next year at Young's Pier in Atlantic City on June 9-16, inclusive. The earlier part of the week will be devoted chiefly to locomotives and accessories, and subjects relating to cars in the latter part of the week. The committees are already appointed under the following chairmen: Entertainment, W. K. Krepps, Crucible Steel Co.; exhibits, J. G. Platt, Hunt-Spiller Mfg. Corporation; enrollment, C. H. Gayetty, Quaker City Rubber Co.; finance, George A. Cooper, Frost Railway Supply Co., and transportation, J. C. Kuhns, Burden Iron Co. J. D. Conway, Oliver building, Pittsburgh, Pa., continues as secretary of the association.

Extending Armstrong Bros. Plant.

Armstrong Bros. Tool Company, of Chicago, are making extensive additions to their plant buildings and equipment. This will include an addition to the Drop Forge department, a new building for the hardening and heat treating department, besides a new building for the general office, and finished stock and shipping department. Building operations are nearly completed, and with extensive additions of new equipment, it will largely increase the company's production, an increase urgently needed to meet its rapidly growing business.

Norwegian Railways.

The Norwegian Government has recently accepted the bids submitted for the electrification of the railway from Christiania to Drammer. The bids include eighteen normal gauge electric locomotives which are to be built at Christiana. This is the first definite step to be taken in the plan for the electrification of the entire Norwegian railway system. The power is to be obtained from the Hakavik power station, which is located not far from Kongsberg, Norway, where can be produced about 25,000 horsepower.

Lignite Briquettes

In Saskatchewan and southwestern Manitoba briquettes from the lignite deposits will be made in the immediate future. A plant costing $400,000 will be established during the coming winter, with a capacity of 30,000 tons a year, and briquettes will be sold to the coal dealers in Winnipeg at $9.40 per ton. The opportunity for enlargement is said to be unlimited. The grade of lignite is said to be of a poor quality, but the finished product will be of the best.

BOOKS, BULLETINS, ETC.

Building the Pacific Railway, by Edwin L. Sabin, published by J. B. Lippincott Company, Philadelphia, Pa. 317 pages, cloth, with 22 illustrations and a map. Price $2.00.

The story of the building of the first railroad from the Mississippi to the Pacific Ocean, from Omaha, Neb., to San Francisco, Cal.—1,770 miles—is told in this book by one eminently qualified for the task. With a keen eye to the picturesque the race of the two construction companies to meet each other in Utah is the story of manly endeavor against time and space and circumstance. Heroic men of various tongues and creeds are united in a mighty impulse to open the gateways that the East and West of a mighty continent might be united. It was a battle with bare hands against the elemental barriers of Nature in her hitherto impenetrable solitude, and in its way an unparalleled triumph of human skill and industry. It is peculiarly fitting that in the present year, the fiftieth anniversary of the completion of the great work, the story should be embalmed in permanent form while some of those who took part in the work are still living. It is also gratifying to note that the work has been done so thoroughly, and a debt of gratitude is due to the author for this notable contribution to the railroad literature of our time.

Electric Arc Cutting and Welding, Published by the Electric Arc Cutting and Welding Company, 222 Halsey street, Newark, N. J. Price $1.25.

This is an admirable instruction book furnishing in compact form complete details of the most approved methods of setting up and operating the A-C cutting and welding machine and electrodes, with useful data on welding definitions, materials and methods. There are over one hundred illustrations illustrating almost every conceivable kind of work that may come into the hands of the welder in every variety of work, and all of which are the results of actual experience that has been crowned by perfect accomplishment. The chief merit of the work is the terse and comprehensive treatment of each particular subject, admitting in this brief and clear method a variety of special welding which we have not seen described or illustrated in any other work of the kind. The book is, therefore not only fitted for the beginner but even the most expert welder may learn much from the work, as the matter has been diligently collected from the most advanced American and European practice. The work deals with all varieties of metals, describing the best methods of treatment for each kind. A carefully prepared index enhances the value of the work.

Baldwin Record.

Tank-Frame Locomotives is the special subject to which Record No. 94, issued by the Baldwin Locomotive Works, is devoted. Nine distinct types are described and illustrated, all of them are of the narrow-gage type and are particularly suitable for industrial contractors, and other classes of special service, and are much employed on lines in foreign countries. The types shown range from the four-coupled tank-frame locomotives for Jayne Arthur Monques, Africa, with a weight of 11,000 lbs., to the six-coupled tank-frame locomotives for the British War Mission, with a total weight of 33,600 lbs. A peculiarity of these locomotives is in the frames constituting the sides of the water tank, which is placed between them. This location of the water tank under the boiler results in a comparatively low center of gravity for the entire locomotive. The valve gear is necessarily placed outside the wheels. A simple design of the Marshall valve gear, modified to suit the requirements of locomotive service, is usually applied, but in the larger sizes the Walschaerts gear is sometimes used. The firebox can be designed to burn coal, wood or oil for fuel.

Sulphur in Coal.

A study of the forms in which sulphur occurs in coal is the subiect treated in Bulletin No. 111, issued by the Engineering Experiment Station, University of Illinois, Urbana, Ill. The authors are A. R. Powell, a graduate of the University, and S. W. Parr, professor of applied chemistry, and it may be briefly stated that their labors have resulted in the development of a method for analyzing the different forms of sulphur in coal, with full descriptions of the apparatus, with a summary of methods for analyzing the different forms of sulphur in coal by other investigators. The book extends to 66 pages with numerous tables and figures. Copies may be had by application to the Experiment Station. Price 30 cents.

The Railway Problem.

Charles Whiting Raker contributed an excellent article to an engineering journal, which is reprinted in pamphlet form, and strongly recommends public co-operation as a solution to secure efficient operation and fair treatment to labor, capital and the public. The pamphlet is being widely distributed among the members of Congress and various organized bodies interested in the future welfare of the railroads. As a solution of the difficult problems involved in the return of the railroads it cannot fail to receive that degree of consideration which the importance of the subject demands.

Superheaters

Bulletin No. 6, issued by the Locomotive Superheater Company, New York, contains a reprint of the report of the Traveling Engineers' Association on the subject of locomotive performance when equipped with superheater appliances, and emphasizes the important advantage to be gained by the use of the superheater. In view of the rapid introduction of the apparatus, the surpassing merits of the device as perfected by the enterprising company are already thoroughly well known. Nothing but a shortage of means keeps many of the older types of locomotives from being equipped with the fuel-saving, power-producing device.

Machine Shop Tools

Catalogue B-17, issued by the Armstrong Brothers Tool Company, Chicago, Ill., presents interesting details in regard to the latest improvements in ratchet drills, tool holders, lathe dogs and other tools and accessories manufactured by the company, which in its special field is unsurpassed.